ERDC/CRREL TR-05-10

Cold Regions Research and Engineering Laboratory

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Short-range Seismic and Acoustic Signature Measurements Through Forest

Stephen N. Decato, Donald G. Albert,
Frank E. Perron Jr., and David L. Carbee

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ABSTRACT: The effect of forests on low frequency military noise propagation is unknown. As part of a joint project, ERDC-CERL and ERDC CRREL conducted measurements at the Lone Star Army Ammunition Plant located in Texarkana, Texas, to investigate these effects. In this report, the short-range measurements conducted by ERDC-CRREL are documented. Blast noise waveforms produced by C4 explosions at distances from 30 to 567 m were recorded and are presented in this report. In all, 42 different explosions were recorded, producing 314 high quality pressure waveforms for analysis. Additional reports documenting the long-range measurements and analyzing the recorded data are in preparation.

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PREFACE

This report was prepared by Stephen N. Decato, Physical Science Technician, Donald G. Albert, Research Geophysicist, Frank E. Perron Jr., Physical Science Technician, and David L. Carbee, Physical Science Technician, Geophysical Sciences Branch, U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory.

In recent years the increase of civilian populations living on the outskirts of U.S. Army installations has led to more frequent noise complaints. While the Army normally uses forest management techniques to ensure the health of the forests on its installations, a question that has arisen is whether these forest practices, including tree harvesting, might adversely impact the noise problem by reducing the noise absorption characteristics of the forested land. Underlying this question is the assumption that forests absorb noise. While this is certainly true at high frequencies (in the kHz band), little work has been done at the lower frequencies (below 100 Hz) often produced by Army demolition and training activities. As a result of this lack of knowledge, ERDC, under the direction of Dr. Larry Pater, ERDC-CERL, is embarking on a study of the low frequency noise attenuation by forests. As part of this study, a joint measurement program involving two ERDC Laboratories, CERL and CRREL, was conducted at the Lone Star Army Ammunition Plant in Texarkana, Texas. The purpose of this report is to document the CRREL measurements. Additional reports will document the CERL measurements and analyze the experimental data to determine the effect of the forest on low frequency military blast noise.

Field personnel during this test included Don Albert, Steve Decato, and Frank Perron from CRREL, and Larry Pater, Mike White, Richard Racioppi, Jeff Mifflin, George Swenson, Brent Miller, and Achal Modi from CERL. The authors especially thank Dave Self, Jesse Stewart, and all the other Lone Star Army Ammunition Plant personnel for their assistance during these measurements. They thank Tom Vorac, U.S. AMC Installations and Security Activity (now with the U.S. Army Environmental Center, Natural Resources), and Dr. Larry Pater, U.S.A ERDC-CERL, for funding this research. Finally, they thank Dr. Pater, Project Leader for Military Noise Management, for the invitation to participate in this project.

This report was prepared under the general supervision of Dr. Richard Detsch, Chief, Geophysical Sciences Branch; and James Wuebben, Acting Director, CRREL.

The Commander of the Engineer Research and Development Center is COL James R. Rowan, EN. The Director is Dr. James R. Houston.

Short-range Seismic and Acoustic Signature Measurements Through Forest

STEPHEN N. DECATO, DONALD G. ALBERT, FRANK E. PERRON JR., AND DAVID L. CARBEE

1 INTRODUCTION

This report documents the measurements and presents the signals recorded during the Blast Noise Propagation Through Forest Test conducted by the U.S. Army ERDC Construction Engineering Research Laboratory and the U.S. Army ERDC Cold Regions Research and Engineering Laboratory. The measurements were conducted at the Lone Star Army Ammunition Plant in Texarkana, Texas, from 23 July through 25 July 2002 to determine the properties of blast noise wave propagation through a forested area. This report contains the recordings made by CRREL; the CERL recordings will be published in a separate report. Use of this and other data sets will assist the Army in determining methods of improving blast noise attenuation in populated areas and enhance forest management techniques.

The blast waves were produced by detonating charges of M112 C4 explosive at various heights and locations. Sledge hammer blows on an aluminum plate and .45 caliber blank rounds were also recorded to provide additional ground and air characterization. Pressure sensors, microphones, and geophones were configured in a straight-line array on the ground and 1.5 m above the ground surface.

The intent of this report is to provide documentation of the CRREL measurements that will accompany the transmittal of the recorded data on CD-ROM to the test participants and sponsor. This report includes a list of the records obtained during the tests, documentation of the sensor array, a table of sensors used, environmental characterization, and a description of the data reduction. Plots of all the signatures are provided, and the signatures themselves are included on a CD-ROM in ASCII format. An analysis report of the signatures shown here will be published separately.

2 OVERVIEW OF TEST

The Lone Star Army Ammunition plant routinely detonates obsolete munitions as a method of disposal. On a typical day, as many as 48 shots, each consisting of about 95 lb (43 kg) of explosives, may be detonated. Although these charges are buried 10 to 15 ft (3 to 5 m) deep in a sandy/silty soil, the shots always “blow out,” sending debris high into the air producing a loud blast wave. In recent years, private homes are being built close to the AAP and other Army facilities’ boundary lines. This has resulted in concerns about noise complaints from new residents. As the current demolition area at the AAP is surrounded by forest, a scientifically unanswered question is what is the effect of this forest on the noise produced by the explosions? If the trees are cut or thinned as a part of normal forest management plan, will the noise complaints increase? To answer this question, the measurements in this report were conducted.

The measurements were conducted at the (new) Demolition Range at the Lone Star AAP. Figure 1 shows an aerial photograph of the test site with the shot locations (marked TC = Test Charge) and sensor locations. The CRREL sensor array was located in the forest south of TC 3. Figure 2 shows a schematic of the CRREL sensor locations and a typical test charge (C-4) shot. Details of the sensor array are given in Section 3 of this report.

Data Recording and Reduction

A Geometrics NZ digital seismograph (Fig. 3) was used to record the signature data from the sensor arrays. We used an 8-kHz sampling rate (0.125 ms) per channel, providing a 3-dB recording bandwidth of 1.75 Hz to 3.3 kHz. Twenty-four sensor channels were recorded for each test charge.

Because of a malfunction with the CRREL blaster box, the actual shot instant could not be recorded and the recorder could not be automatically started as we normally do. Instead, the recordings were started manually and the shot instant was determined afterwards from the blast wave arrival times. This correction procedure is discussed in Section 6.

The seismograph produces binary data files in an industry standard format called SEG-2. These binary files contain the raw voltage output of the sensors, but contain no other information. We converted these binary files into ASCII files using the MATLAB program listed in Appendix B. The ASCII files have the correct physical units, time information, and sensor location details. The signature plots presented in Appendix A were produced by the MATLAB program

listed in Appendix C from the ASCII data files. Additional data analysis will be performed using only the ASCII data files.

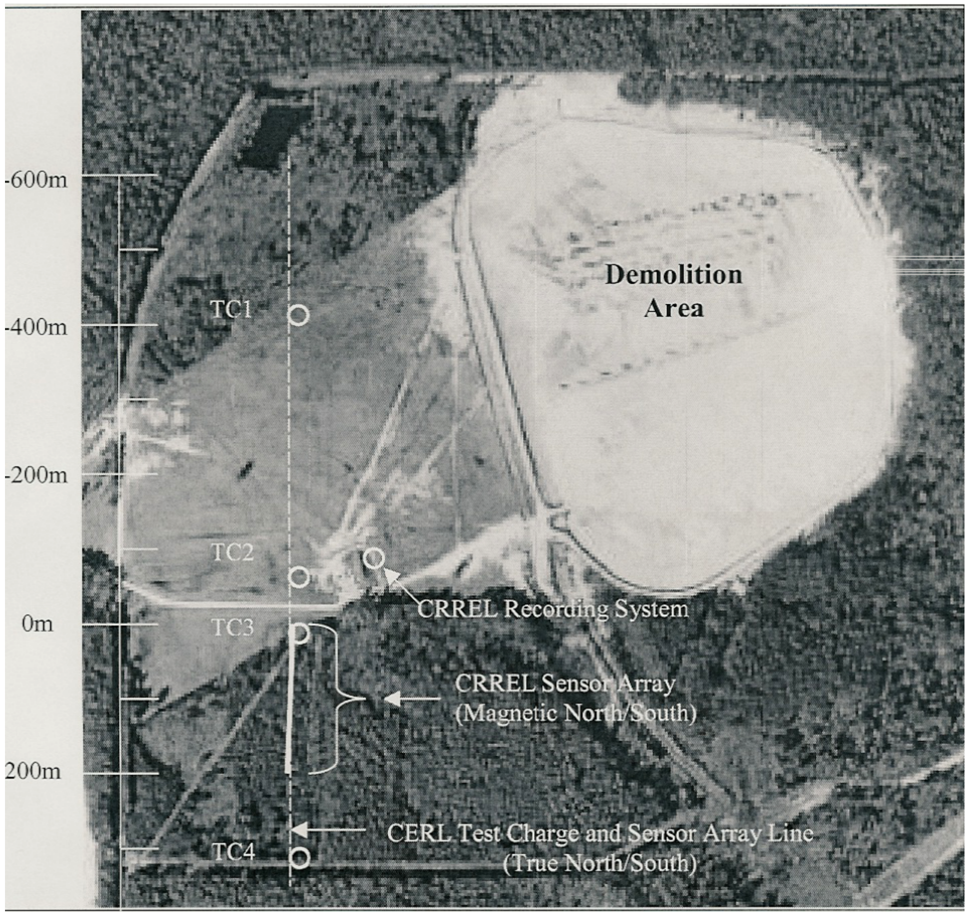


Figure 1. View of the Lone Star AAP test range, with approximate locations of test charge and sensor locations.

C4 detonation at TC 2

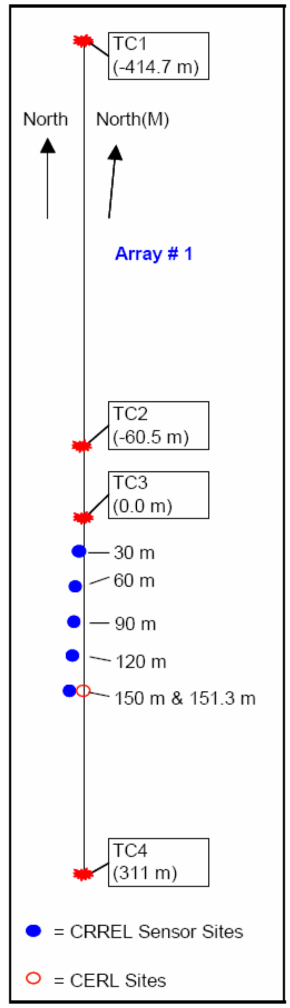


Figure 2. Test Charge Site 2 (TC 2) and a sketch of the test array.

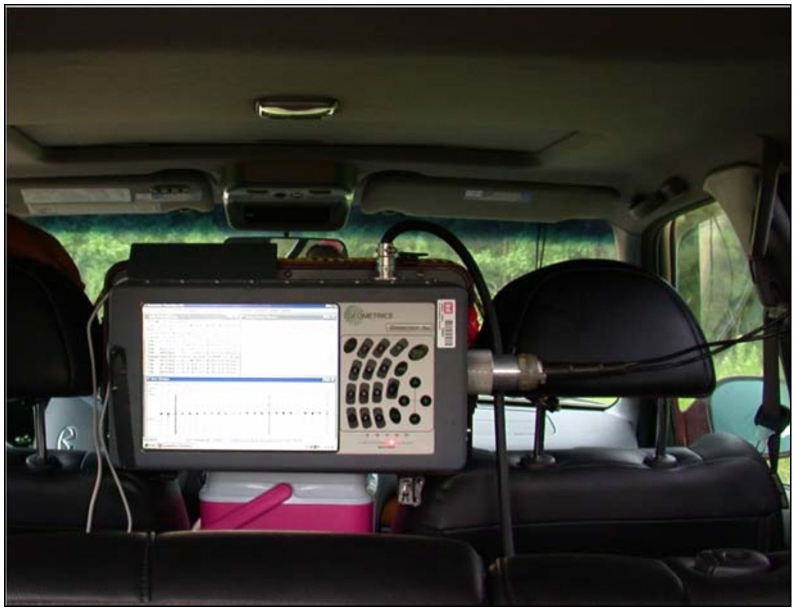


Figure 3. Geometrics NZ Digital Seismograph, set up inside a vehicle parked behind a protection soil berm.

List of Signature Records

The measurements were conducted without interfering with the normal demolition operations. This meant that the forest testing was delayed and personnel were evacuated from the test site when demolition shots were fired. While we did take advantage of this opportunity to record some of these demolition shots using a separate small sensor array located in the safety zone, those recordings are not of client interest to this study and are not included in this report. They do, however, affect the numbering of the records and files recorded by the digital seismograph.

The following list contains the types of data recorded for the Blast Noise Propagation Test and is included on the CD. NZ file names like “1.dat” through “199.dat” have been converted to multichannel ASCII files with the correct physical units. File names like “TX02002.asc” through “TX02046.asc” are files numbered so that they correspond to CERL’s C4 shot numbers. Munition demolition records have been omitted from this report. Table 1 contains the list of signature records. Figures 4 and 5 show our C4 charges and .45-calibre pistol.

Table 1. Signature records.

1.dat – 19.dat	.45 cal. blank
20.dat – 27.dat	Microphone calibration
28.dat – 38.dat	Demolition of munitions
39.dat – 44.dat	C4
45.dat	Noise Record
46.dat – 56.dat	Demolition of munitions
57.dat – 58.dat	Noise Record
59.dat	Demolition of munitions
60.dat – 68.dat	C4
69.dat	Noise Record
70.dat – 74.dat	C4
75.dat – 81.dat	Demolition of munitions
82.dat – 91.dat	Calibration
92.dat	Noise Record
93.dat – 113.dat	C4
114.dat – 199.dat	Calibration

Specifications for Sources used in Measurements

C4	½ brick	0.63 lb (0.28 kg)
	1 brick	1.25 lb (0.57 kg)
	2 bricks	2.50 lb (1.23 kg)
	4 bricks	5.00 lb (2.27 kg)
	5 bricks	6.25 lb (2.84 kg)
	8 bricks	10.00 lb (4.55 kg)
	10 bricks	12.50 lb (5.67 kg)
.45 cal blank	Overall Length	0.89 in. (22.6 mm)
	Case Length	0.89 in. (22.6 mm)
	Cartridge Weight	7.6 g
	Case Weight	5.8 g
	Powder Weight	31 g
	Powder Type	Black, FFFFG, CCI
	Primer Type	Magnum
	Manufacture	Custom made
10-lb (4.5-kg) sledge hammer	Overall Length	34 in. (86.7 cm)
	Overall Weight	11.68 lb (5.30 kg)
	Head Weight	10.0 lb (4.55 kg)
	Strike Plate Material	6061T6 Aluminum
	Strike Plate Area	103.1 in.^{2} (668 cm^2)
	Strike Plate Thickness	1 in. (2.54 cm)
	Strike Plate Weight	10.36 lb. (4.70 kg)

Figure 4. .45-caliber calibration pistol firing blanks at a 1-m height.

a. C4 being formed into a 5-lb (2.25-kg) spherical charge.

Figure 5. Making the C4 charges.

b. A 1.25-lb (0.68-kg) brick of C4.

c. C4 spherical charge being suspended at TC 3.

Figure 5 (con't). Making the C4 charges.

3 CRREL SENSOR CONFIGURATION

The sensor configuration installed by CRREL consisted of a linear array with multi-sensor stations. The array was located in the forest between TC 3 and TC 4. It extended from 30 to 151.3 m magnetic south of TC 3. The goal of this sensor array was to obtain a detailed view of the blast waves as they propagated into the forest.

CERL also installed and recorded signatures from their own independent sensor array. This array was located both inside and outside of the forest on a true north-south line. This array was designed to obtain a complete overview of the blast wave propagation at the site as well as details of the blast wave generation by the source.

Table 2 lists the distances between the CRREL and CERL locations. This difference was due to a 3.5 degree east deviation between true north and magnetic north.

Figures 6 through 11 show the locations of the of the CRREL instrument stations. Table 3 details the sensors used in the CRREL Blast Wave Propagation Array. Table 4 notes any sensor changes made to that array, during the measurements.

Figure 12 shows the CRREL array used to record the large munitions demolition shots. Further discussion of this array is omitted from this report.

Table 2. Distances between the CRREL and CERL locations.

Location	Distance (m)
30 meters	1.83
60 meters	3.66
90 meters	5.49
120 meters	7.32
150 meters	9.15

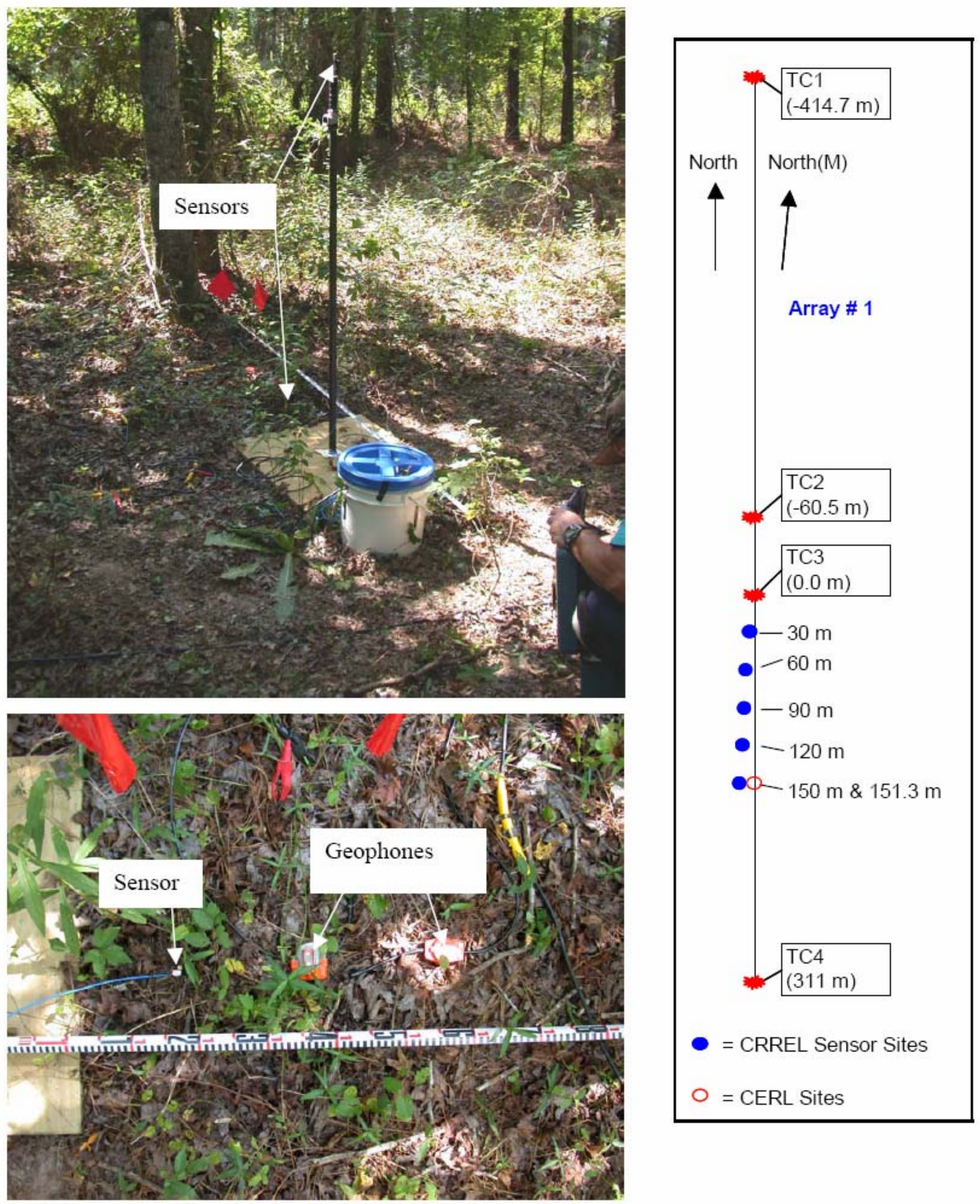


Figure 6. 30 meter sensor locations.

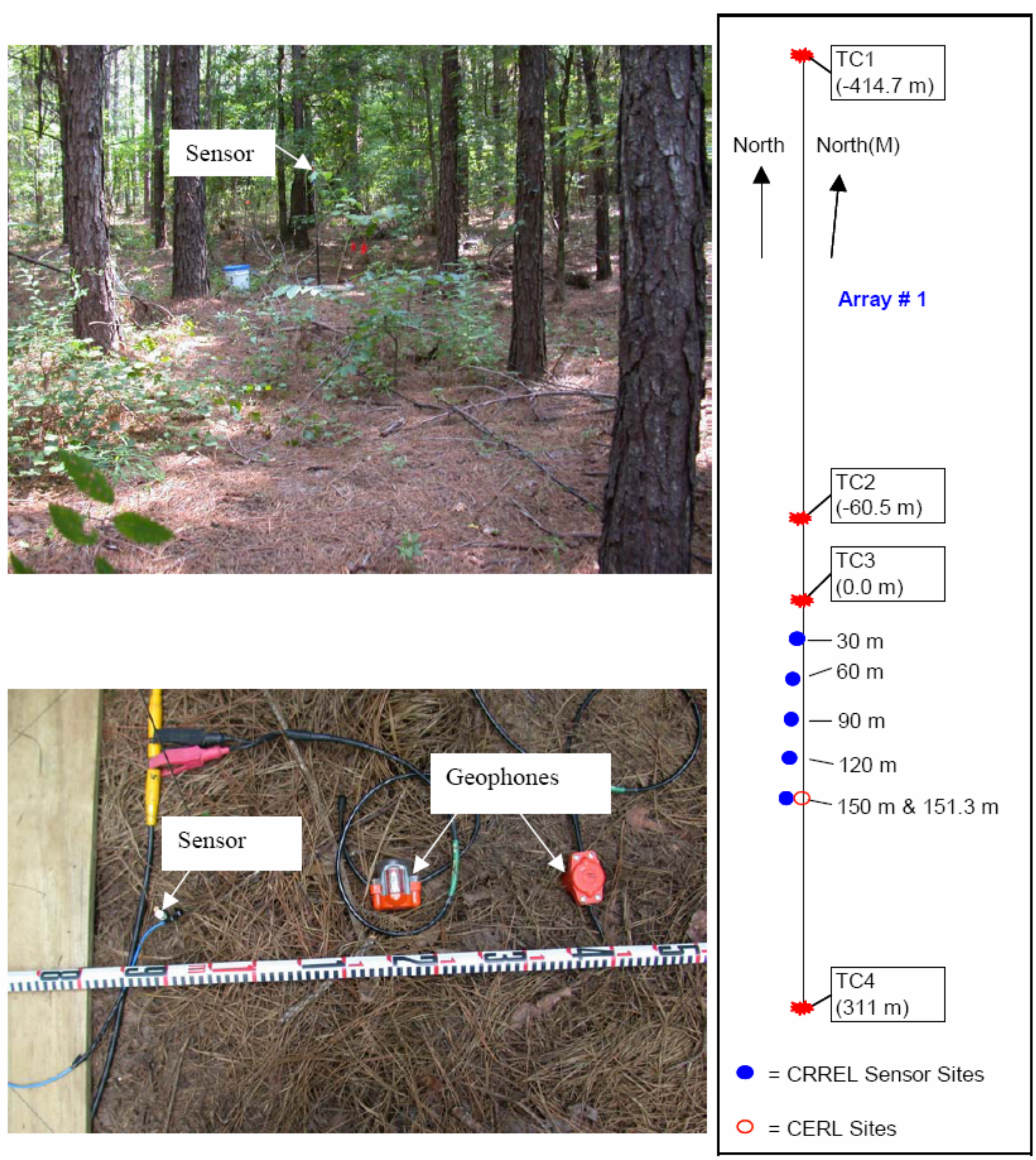


Figure 7. 60 meter sensor locations.

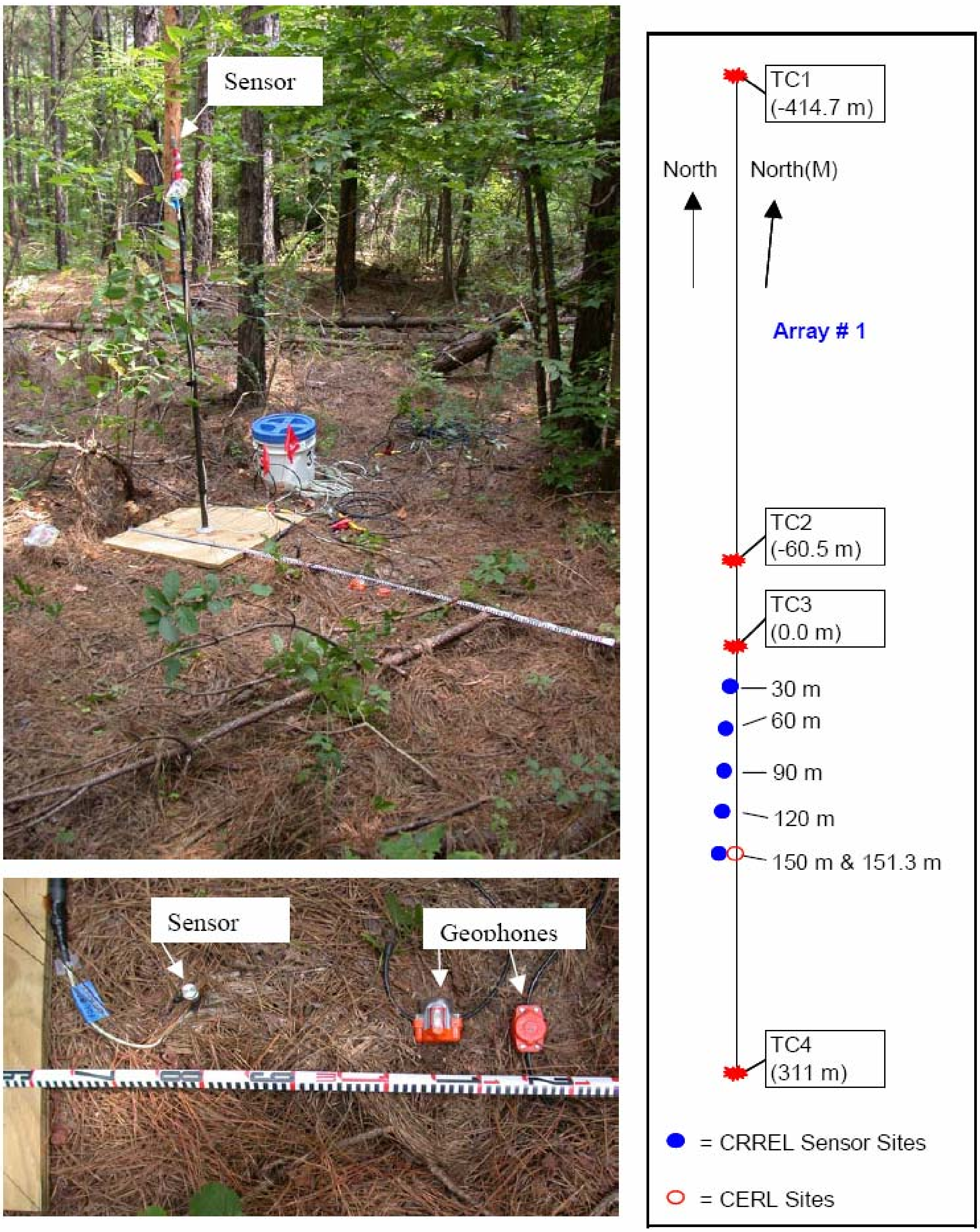


Figure 8. 90 meter sensor locations.

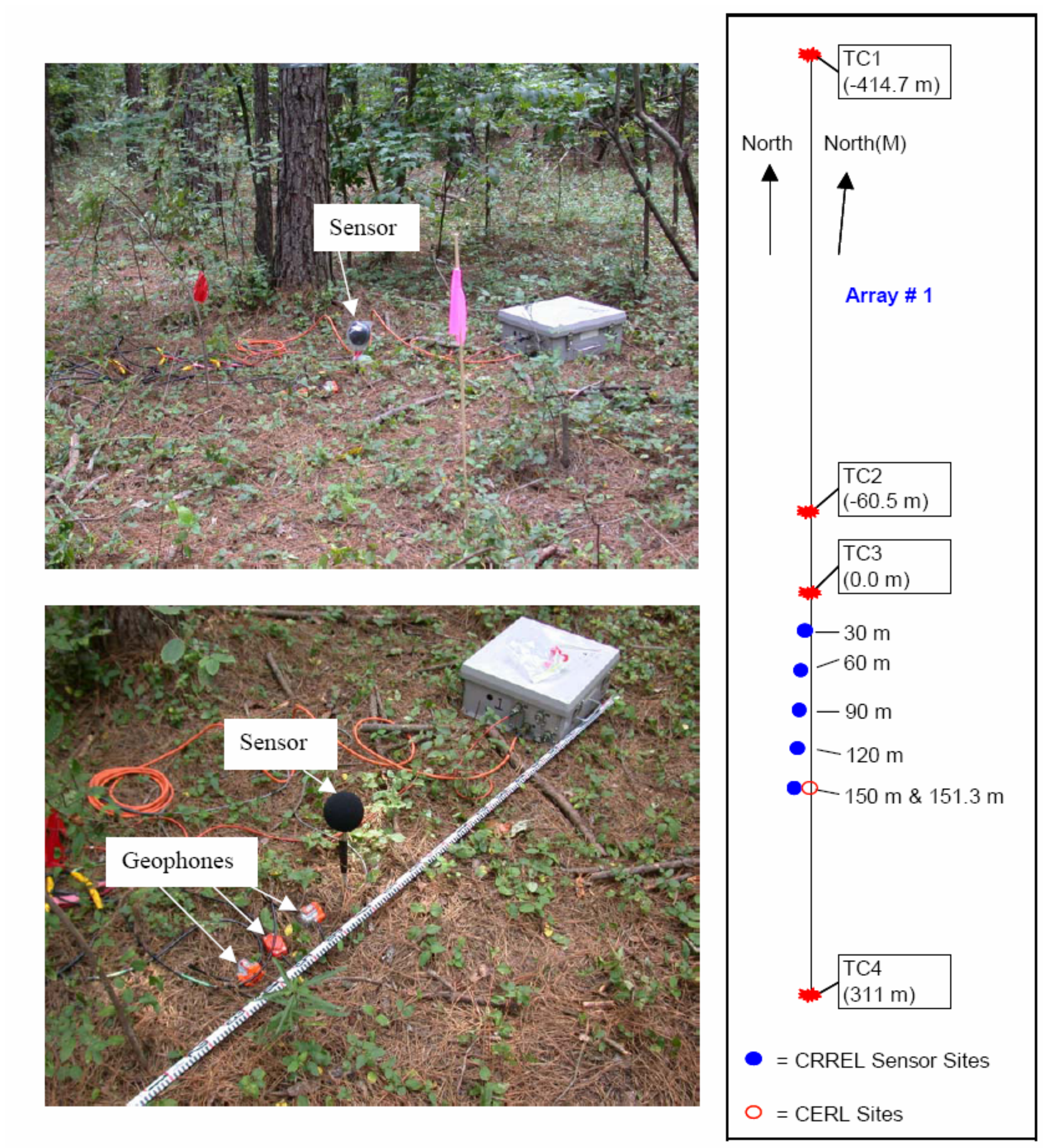


Figure 9. 120 meter sensor locations.

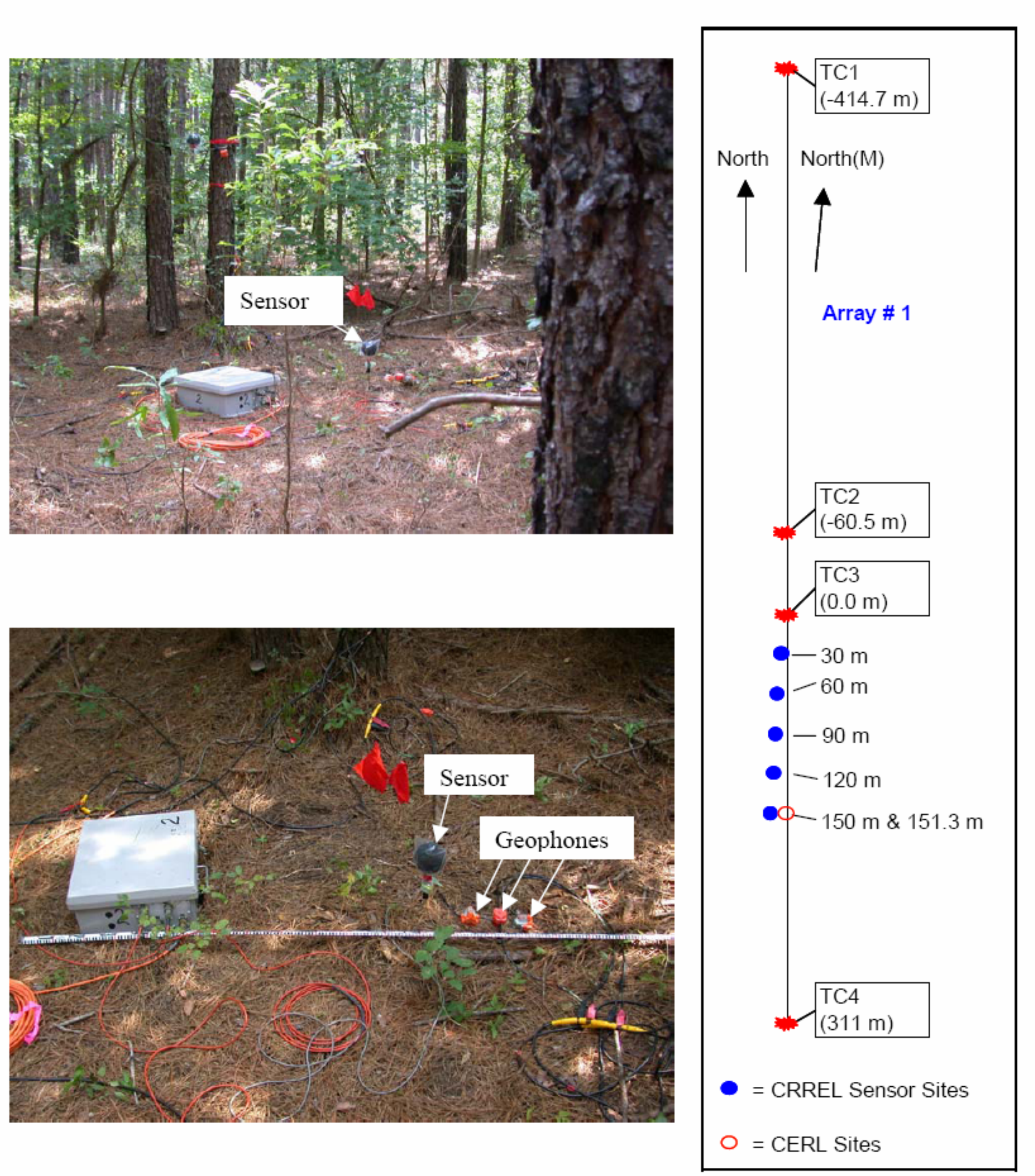


Figure 10. 150 meter sensor locations.

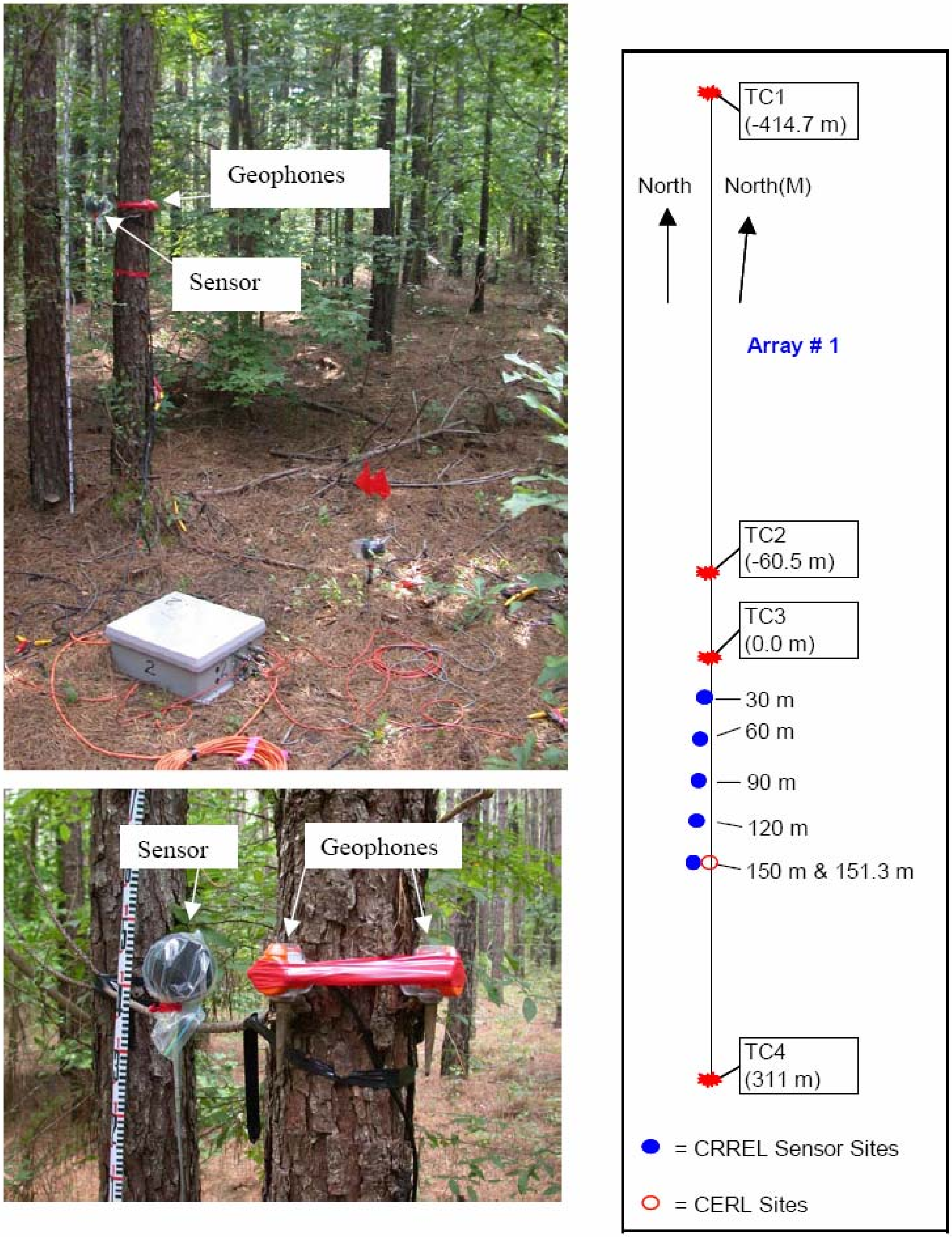


Figure 11. 153.1 meter sensor locations.

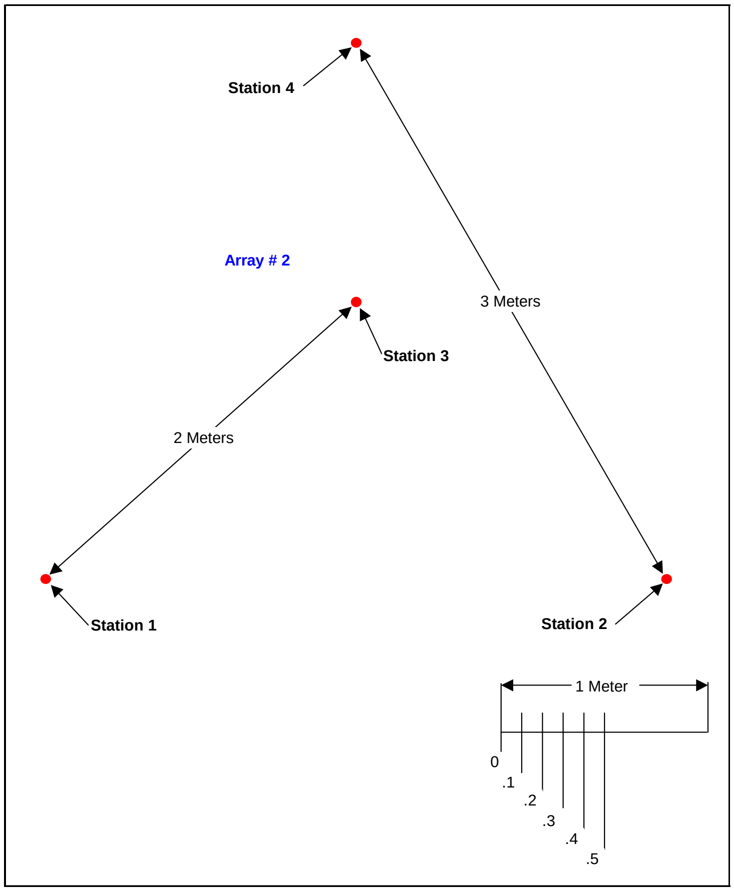


Figure 12. CRREL munitions demolition array. This array was located approximately 600 to 900 m from the demolition charges, with Station 4 closest to the charges.

Table 3. Wave propagation sensor array.

Array Cable 1

Location	Channel Number	Sensor	Serial Number	Height (m)	Calibrated Sensitivity
30 Meter	1	Radial geophone	H13	0.0	32.2 V/m/s
30 Meter	2	Vertical geophone	V23	0.0	32.2 V/m/s
30 Meter	3	PCB 102A07	15972	0.0	1.28E-02 mV/Pa
30 Meter	4	PCB 102A07	15973	1.5	1.24E-02 mV/Pa
60 Meter	5	Radial geophone	H2	0.0	32.2 V/m/s
60 Meter	6	Vertical geophone	V11	0.0	32.2 V/m/s
60 Meter	7	PCB 102A07	15971	0.0	1.30E-02 mV/Pa
60 Meter	8	PCB 106B50	6693	1.5	6.74E-02 mV/Pa
90 Meter	9	Radial geophone	H18	0.0	32.2 V/m/s
90 Meter	10	Vertical geophone	V4	0.0	32.2 V/m/s
90 Meter	11	PCB 106B50	3259	0.0	8.17E-02 mV/Pa
90 Meter	12	PCB 106B50	6695	1.5	7.16E-02 mV/Pa (uncal)

Array Cable 2

Location	Channel Number	Sensor Number	Sensor S/N	Height (m)	Calibrated Sensitivity
120 Meter	13	Radial geophone	H28	0.0	32.2 V/m/s
120 Meter	14	Transv. geophone	H19	0.0	32.2 V/m/s
120 Meter	15	Vertical geophone	V6	0.0	32.2 V/m/s
120 Meter	16	B&K 4938 - 3	2239255	0.0	1.15 E-3 mV/Pa
150 Meter	17	Radial geophone	H20	0.0	32.2 V/m/s
150 Meter	18	Transv. geophone	H21	0.0	32.2 V/m/s
150 Meter	19	Vertical geophone	V28	0.0	32.2 V/m/s
150 Meter	20	B&K 4938 - 2	2239254	0.0	1.32 E-3 mV/Pa
151.3 Meter	21	Radial geophone	H10	1.5	32.2 V/m/s
151.3 Meter	22	Transv. geophone	H9	1.5	32.2 V/m/s
151.3 Meter	23	Vertical geophone	V?	1.5	32.2 V/m/s
151.3 Meter	24	B&K 4938 - 1	2239253	1.5	1.20 E-3 mV/Pa

All geophones are Mark Products L-15, 4.5 Hz
All B&K microphones had 1:1000 attenuation.

Table 4. Changes to wave propagation sensor array.

The PCB sensor at the 60 m location failed and was replaced after CRREL binary file number 44, or CERL shot number 6.

Location	Channel	Sensor Number	Sensor S/N	Height	Calibrated Sensitivity
60 Meter	7	PCB 106B50	3260	0.0	7.16E-02 mV/Pa
60 Meter	7	PCB 102A07	15971	0.0	1.30E-02 mV/Pa

A = Binary records 45 - 199
B = Binary records 1 - 44

The B&K 4938 microphones at locations 120 m and 150 m were replaced with with B&K 4165 microphones for blank pistol shots 5 - 19, ascii files 105 - 119, plus the associated calibration files.

Location	Channel Number	Sensor Number	Sensor S/N	Height (m)	Calibrated Sensitivity
120 Meter	16 A	B&K 4938 - 3	2239255	0.0	1.15 E-3 mV/Pa
120 Meter	16 B	B&K 4165 - 5	1881043	0.0	0.75 E-3 mV/Pa
150 Meter	20 A	B&K 4938 - 2	2239254	0.0	1.32 E-3 mV/Pa
150 Meter	20 B	B&K 4165 - 6	1857571	0.0	0.73 E-3 mV/Pa

A = Binary records 39 - 199
B = Binary records 5 - 27
The 4165 microphones had too low of a calibration value, so may not be reliable.

4 SENSOR CALIBRATION

Tables 3 and 4 list the sensitivities used to convert the voltages recorded by the seismograph to physical units. These two tables also contain the calibration values for all sensors used. The sensitivities were determined as follows:

- *Geophones*: The sensitivity provided by the manufacturer was used. From past experience at CRREL, these sensors are usually accurate to about 10%, but they can occasionally vary more than this range because of differences in coupling to the ground.
- *Pressure Sensors* (solid state): The PCB pressure sensors were calibrated in situ using a Trig-Tek Model 402H calibrator (Fig. 13). This model calibrator provides sound pressure levels of 120 to 160 dB in 10-dB increments. We used levels of 140, 150, and 160 dB for these calibrations to match the expected blast noise levels. It has selectable internal low frequency outputs of 62.5, 125, 250, 500 and 1000 Hz. We relied mostly on the lower frequencies, 62.5–250 Hz, for these calibrations.
- *Microphones* (¼ and ½ inch B&K): The B&K ¼ inch Model 4938 microphones were also calibrated using the Trig-Tek Model 402H calibrator at 140 and 150 dB.

Figure 13. Typical sensor calibration using the Trig-Tek Model 402H calibrator.

The B&K ½ inch Model 4165 microphones were calibrated using a GenRad Type 1562-A sound level calibrator. This type of calibrator provides a sound pressure level of 114 dB. It has selectable internal frequency outputs of 125, 250, 500, 1000 and 2000 Hz.

5 FOREST ENVIRONMENT

Figures 13 through 19 show typical views of the conditions within the forest. The understory vegetation limited visibility to about 30–60 m within the forest. Details of the tree species and density are to be provided by forest measurements already conducted as part of the land management at the Lone Star AAP.

Ground conditions usually consisted of a layer of needles a few inches thick, as seen in the photographs. The weather during the tests was very hot and humid, with air temperatures typically near 100°F (38°C).

Figure 14. Vegetation at 30 meter site.

Figure 15. Vegetation at 60 m site.

Figure 16. Vegetation at 90 m site.

Figure 17. Vegetation at 120 m site.

Figure 18. Vegetation at 150 m site.

Figure 19. Vegetation at 151.3 m site.

6 TEXAS 2002 TIME BREAK CORRECTIONS AND ACOUSTIC VELOCITIES

Because of a malfunction with the blaster box, good time breaks were not obtained. The seismograph recordings were started manually during the countdown, so the blast wave arrivals occur at different times within the binary file.

Before writing the ASCII files, the true time break was found by finding the blast wave arrival times and the correct zero time from the acoustic velocity. These corrections are listed below. In the ASCII files, the blast wave arrivals occur at the true arrival time.

In this listing, the shot number is the original CRREL binary file (xx.dat) recorded by the NZ seismograph. For C4 shots, the ASCII file name with the time break corrections applied is tx020xx.asc, where xx is the CERL number given below. For pistol shots, the

- ASCII file name is tx021xx.asc, where xx is the CRREL shot number.
- (For shot 40, the binary file is 40.dat and the ascii file is tx2002.asc.)
- (For shot 1, the binary file is 1.dat and the ascii file is tx2101.asc.)

The acoustic velocities listed below for the pistol shots are higher than the true velocities because of the offset of the pistol from the line of the sensors. As the pistol was only 2 m away from the nearest sensor, this did not affect the time break correction.

The records are sorted by shot location below.

```
Shot 60 TC2 CERL 7 Velocity = 349.7 m/s TB corr = -0.0465 7-24-02
Shot 62 TC2 CERL 9 Velocity = 348.0 m/s TB corr = -2.5717 7-24-02
Shot 66 TC2 CERL 13 Velocity = 348.2 m/s TB corr = 0.0052 7-24-02
Shot 70 TC2 CERL 3B Velocity = 347.4 m/s TB corr = -1.2592 7-25-02
Shot 71 TC2 CERL 4B Velocity = 347.3 m/s TB corr = -1.0796 7-25-02
Shot 72 TC2 CERL 5B Velocity = 348.2 m/s TB corr = -1.3115 7-25-02
Shot 73 TC2 CERL 6B Velocity = 348.7 m/s TB corr = -1.2592 7-25-02
Shot 74 TC2 CERL 7B Velocity = 348.6 m/s TB corr = -1.0384 7-25-02
Shot 94 TC2 CERL 17 Velocity = 349.6 m/s TB corr = -0.3061 7-25-02
Shot 97 TC2 CERL 21 Velocity = 350.7 m/s TB corr = -0.2621 7-25-02
Shot 101 TC2 CERL 25 Velocity = 350.5 m/s TB corr = -0.5556 7-25-02
Shot 105 TC2 CERL 29 Velocity = 351.0 m/s TB corr = -0.6646 7-25-02
Shot 108 TC2 CERL 32 Velocity = 352.3 m/s TB corr = -0.8483 7-25-02
```

```
Shot 109 TC2 CERL 33 Velocity = 352.7 m/s TB corr = -1.2742 7-25-02
Shot 110 TC2 CERL 34 Velocity = 351.8 m/s TB corr = -1.5879 7-25-02
Shot 111 TC2 CERL 35 Velocity = 352.4 m/s TB corr = -1.0272 7-25-02
Shot 112 TC2 CERL 36 Velocity = 351.9 m/s TB corr = -0.9628 7-25-02
Shot 113 TC2 CERL 37 Velocity = 351.5 m/s TB corr = -1.2390 7-25-02

Shot 61 TC1 CERL 8 Velocity = 350.2 m/s TB corr = 1.2226 7-24-02
Shot 65 TC1 CERL 12 Velocity = 348.6 m/s TB corr = 0.2675 7-24-02
Shot 93 TC1 CERL 16 Velocity = 352.9 m/s TB corr = -0.4247 7-25-02
Shot 96 TC1 CERL 20 Velocity = 348.7 m/s TB corr = -0.2756 7-25-02
Shot 100 TC1 CERL 24 Velocity = 351.5 m/s TB corr = -0.6963 7-25-02
Shot 104 TC1 CERL 28 Velocity = 351.0 m/s TB corr = -0.8121 7-25-02

Shot 40 TC3 CERL 2 Velocity = 350.4 m/s TB corr = -0.2134 7-24-02
Shot 41 TC3 CERL 3 Velocity = 349.0 m/s TB corr = -0.2179 7-24-02
Shot 42 TC3 CERL 4 Velocity = 350.5 m/s TB corr = -0.2174 7-24-02
Shot 67 TC3 CERL 14 Velocity = 348.7 m/s TB corr = 0.0880 7-24-02
Shot 98 TC3 CERL 22 Velocity = 350.6 m/s TB corr = -1.4086 7-25-02
Shot 102 TC3 CERL 26 Velocity = 350.4 m/s TB corr = -0.7076 7-25-02
Shot 106 TC3 CERL 30 Velocity = 350.9 m/s TB corr = -0.4905 7-25-02

Shot 64 TC4 CERL 11 Velocity = 353.1 m/s TB corr = -0.8379 7-24-02
Shot 68 TC4 CERL 15 Velocity = 353.3 m/s TB corr = -1.0028 7-24-02
Shot 95 TC4 CERL 19 Velocity = 355.0 m/s TB corr = -1.1580 7-25-02
Shot 99 TC4 CERL 23 Velocity = 355.2 m/s TB corr = -1.2413 7-25-02
Shot 103 TC4 CERL 27 Velocity = 355.4 m/s TB corr = -1.5833 7-25-02
Shot 107 TC4 CERL 31 Velocity = 355.7 m/s TB corr = -2.0720 7-25-02
```

Blank Pistol Shots

(The velocity is an apparent phase velocity, not the true acoustic velocity, because the source was offset from the sensor line.)

```
Shot 1 30m Velocity = 362.3 m/s TB corr = 0.8091 7-23-02
Shot 2 30m Velocity = 362.5 m/s TB corr = 0.5928 7-23-02
Shot 3 30m Velocity = 362.8 m/s TB corr = 0.9599 7-23-02
Shot 4 30m Velocity = 363.9 m/s TB corr = 1.2268 7-23-02
Shot 15 30m Velocity = 362.3 m/s TB corr = 0.9330 7-24-02
Shot 16 30m Velocity = 362.0 m/s TB corr = 1.2151 7-24-02
Shot 17 30m Velocity = 362.0 m/s TB corr = 1.3954 7-24-02
Shot 18 30m Velocity = 362.0 m/s TB corr = 1.1648 7-24-02
Shot 19 30m Velocity = 362.3 m/s TB corr = 1.1863 7-24-02
```

```
Shot 5 90m Velocity = 356.9 m/s TB corr = 1.4087 7-24-02
Shot 6 90m Velocity = 359.0 m/s TB corr = 1.4700 7-24-02
Shot 7 90m Velocity = 358.2 m/s TB corr = 1.0701 7-24-02
Shot 8 90m Velocity = 358.5 m/s TB corr = 1.0898 7-24-02
Shot 9 90m Velocity = 359.0 m/s TB corr = 1.2376 7-24-02

Shot 10 60m Velocity = 364.2 m/s TB corr = 1.2334 7-24-02
Shot 11 60m Velocity = 364.5 m/s TB corr = 1.2090 7-24-02
Shot 12 60m Velocity = 364.5 m/s TB corr = 1.2828 7-24-02
Shot 13 60m Velocity = 364.5 m/s TB corr = 1.0293 7-24-02
Shot 14 60m Velocity = 364.5 m/s TB corr = 1.3029 7-24-02
```

7 SIGNATURE RECORDINGS AND DATA QUALITY

This section provides plots of all of the C4 test charges and all of the .45 caliber pistol shots recorded by the CRREL sensor array. The plots were produced using the ASCII data files and the MATLAB plot program listed in Appendix C.

Table 5 lists the events recorded during the tests. As explained in Appendix B, the binary data file names were changed to agree with the CERL Test Charge numbering system. Also, to avoid duplicate file names, the .45 caliber shot files were renumbered in the range 101–119.

Table 6 gives an assessment of the data quality of each trace, based on the plots in this section. The table lists “good” data suitable for additional analysis. “Bad” data should not be used, at least not without further processing. The data might be bad because of sensor failure or too high a noise level.

Nine pressure sensor channels were recorded for each of the C4 shots. For the 42 C4 shots detonated during the test, five shots were not recorded because of a failure with the time break signal. Four other channels were unusable, while 15 were usable but noisy.

Appendix A shows each individual record that was made.

Table 5. Chronology of recorded events.

CRREL File Name	CERL Shot #	ASCII File Name	Date	Local Time	Source	Source Ht. m (ft/in.)	Comments
1.dat		TX02101.asc	07/23/02	1545	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
2.dat		TX02102.asc	07/23/02	1553	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
3.dat		TX02103.asc	07/23/02	1555	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
4.dat		TX02104.asc	07/23/02	1556	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
5.dat		TX02105.asc	07/24/02	0749	.45 cal. blank	1.0 (3/3)	Shot 2m west of 90 m site
6.dat		TX02106.asc	07/24/02	0753	.45 cal. blank	1.0 (3/3)	Shot 2m west of 90 m site
7.dat		TX02107.asc	07/24/02	0754	.45 cal. blank	1.0 (3/3)	Shot 2m west of 90 m site
8.dat		TX02108.asc	07/24/02	0755	.45 cal. blank	1.0 (3/3)	Shot 2m west of 90 m site
9.dat		TX02109.asc	07/24/02	0756	.45 cal. blank	1.0 (3/3)	Shot 2m west of 90 m site
10.dat		TX02110.asc	07/24/02	0807	.45 cal. blank	1.0 (3/3)	Shot 2m east of 60 m site
11.dat		TX02111.asc	07/24/02	0809	.45 cal. blank	1.0 (3/3)	Shot 2m east of 60 m site
12.dat		TX02112.asc	07/24/02	0810	.45 cal. blank	1.0 (3/3)	Shot 2m east of 60 m site
13.dat		TX02113.asc	07/24/02	0811	.45 cal. blank	1.0 (3/3)	Shot 2m east of 60 m site
14.dat		TX02114.asc	07/24/02	0811	.45 cal. blank	1.0 (3/3)	Shot 2m east of 60 m site
15.dat		TX02115.asc	07/24/02	0817	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
16.dat		TX02116.asc	07/24/02	0818	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
17.dat		TX02117.asc	07/24/02	0818	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
18.dat		TX02118.asc	07/24/02	0819	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
19.dat		TX02119.asc	07/24/02	0819	.45 cal. blank	1.0 (3/3)	Shot 2m east of 30 m site
20.dat			07/24/02		Calibration		20.dat thru 27.dat are calibration files
27.dat			07/24/02	0909	Calibration		
28.dat			07/24/02	1009	Munition Demo		28.dat thru 38.dat are munition demo files
38.dat			07/24/02	1014	Munition Demo		
39.dat	1		07/24/02	1218	C4 (1 brick)	1.9 (6/3)	TC2 (See Note 1)
40.dat	2	TX02002.asc	07/24/02	1235	C4 (4 bricks)	1.9 (6/3)	TC2
41.dat	3	TX02003.asc	07/24/02	1334	C4 (1 brick)	3.8 (12/6)	TC2
42.dat	4	TX02004.asc	07/24/02	1345	C4 (1 brick)	3.8 (12/6)	TC2
43.dat	5		07/24/02	1356	C4 (1 brick)	1.2 (4/0)	TC2 (See Note 1)
44.dat	6		07/24/02	1406	C4 (1 brick)	0.6 (2/0)	TC2 (See Note 1)
45.dat			07/24/02	1515	Noise Record		
46.dat			07/24/02	1515	Munition Demo		46.dat thru 56.dat are munition demo files
56.dat			07/24/02	1519	Munition Demo		
57.dat			07/24/02	1520	Noise Record		
58.dat			07/24/02	1529	Noise Record		
59.dat			07/24/02	1532	Munition Demo		

Note 1. CRREL shotbox sent early time break. No ascii file.

Table 5 (cont'd). Recorded events.

CRREL File Name	CERL Shot #	ASCII File Name	Date	Local Time	Source	Source Ht. m (ft/in.)	Comments
60.dat	7	TX02007.asc	07/24/02	1550	C4 (1 brick)	0.3 (1/0)	TC2
61.dat	8	TX02008.asc	07/24/02	1613	C4 (1 brick)	1.9 (6/3)	TC1
62.dat	9	TX02009.asc	07/24/02	1614	C4 (1 brick)	1.9 (6/3)	TC2
63.dat	10		07/24/02	1615	C4 (1 brick)	1.9 (6/3)	TC3 (See Note 1)
64.dat	11	TX02011.asc	07/24/02	1617	C4 (1 brick)	1.9 (6/3)	TC4
65.dat	12	TX02012.asc	07/24/02	1631	C4 (1 brick)	1.9 (6/3)	TC1
66.dat	13	TX02013.asc	07/24/02	1633	C4 (1 brick)	1.9 (6/3)	TC2
67.dat	14	TX02014.asc	07/24/02	1634	C4 (1 brick)	1.9 (6/3)	TC3
68.dat	15	TX02015.asc	07/24/02	1635	C4 (1 brick)	1.9 (6/3)	TC4
69.dat			07/25/02	0820	Noise Record		
70.dat	43	TX02043.asc	07/25/02	0859	C4 (1 brick)	3.8 (12/6)	TC2 Repeat of CERL shot # 3
71.dat	44	TX02044.asc	07/25/02	0910	C4 (1 brick)	3.8 (12/6)	TC2 Repeat of CERL shot # 4
72.dat	45	TX02045.asc	07/25/02	0933	C4 (1 brick)	3.0 (10/0)	TC2 Repeat of CERL shot # 5
73.dat	46	TX02046.asc	07/25/02	0942	C4 (1 brick)	1.2 (4/0)	TC2 Repeat of CERL shot # 6
74.dat	47	TX02047.asc	07/25/02	0951	C4 (1 brick)	0.3 (1/0)	TC2 Repeat of CERL shot # 7
75.dat			07/25/02	1005	Munition Demo		75.dat thru 81.dat are munition demo files
81.dat			07/25/02		Munition Demo		
82.dat			07/25/02	1013	Calibration		82.dat thru 91.dat are munition demo files
91.dat			07/25/02	1019	Calibration		
92.dat			07/25/02	1103	Noise Record		
93.dat	16	TX02016.asc	07/25/02	1106	C4 (1 brick)	1.9 (6/3)	TC1
94.dat	17	TX02017.asc	07/25/02	1107	C4 (1 brick)	1.9 (6/3)	TC2
	18		07/25/02	1107	C4 (1 brick)	1.9 (6/3)	TC3 (See note 2)
95.dat	19	TX02019.asc	07/25/02	1108	C4 (1 brick)	1.9 (6/3)	TC4
96.dat	20	TX02020.asc	07/25/02	1122	C4 (5 pounds)	1.9 (6/3)	TC1 (See note 3)
97.dat	21	TX02021.asc	07/25/02	1123	C4 (5 pounds)	1.9 (6/3)	TC2
98.dat	22	TX02022.asc	07/25/02	1124	C4 (5 pounds)	1.9 (6/3)	TC3
99.9at	23	TX02023.asc	07/25/02	1125	C4 (5 pounds)	1.9 (6/3)	TC4
100.dat	24	TX02024.asc	07/25/02	1143	C4 (5 pounds)	1.9 (6/3)	TC1
101.dat	25	TX02025.asc	07/25/02	1144	C4 (5 pounds)	1.9 (6/3)	TC2
102.dat	26	TX02026.asc	07/25/02	1145	C4 (5 pounds)	1.9 (6/3)	TC3
103.dat	27	TX02027.asc	07/25/02	1146	C4 (5 pounds)	1.9 (6/3)	TC4
104.dat	28	TX02028.asc	07/25/02	1202	C4 (5 pounds)	1.9 (6/3)	TC1
105.dat	29	TX02029.asc	07/25/02	1203	C4 (5 pounds)	1.9 (6/3)	TC2
106.dat	30	TX02030.asc	07/25/02	1204	C4 (5 pounds)	1.9 (6/3)	TC3

Note 2. Time break failed. No binary or ascii file.

Note 3. All C-4 charges detonated to create files 96.dat through 113.dat were done using spherical charges, not preformed bricks.

Table 5 (cont'd).

CRREL File Name	CERL Shot #	ASCII File Name	Date	Local Time	Source	Source Ht. m (ft/in.)	Comments
107.dat	31	TX02031.asc	07/25/02	1204	C4 (5 pounds)	1.9 (6/3)	TC4
108.dat	32	TX02032.asc	07/25/02	1316	C4 (5 pounds)	1.9 (6/3)	TC2
109.dat	33	TX02033.asc	07/25/02	1325	C4 (5 pounds)	3.8 (12/6)	TC2
110.dat	34	TX02034.asc	07/25/02	1336	C4 (5 pounds)	3.8 (12/6)	TC2
111.dat	35	TX02035.asc	07/25/02	1347	C4 (5 pounds)	3.0 (10/0)	TC2
112.dat	36	TX02036.asc	07/25/02	1356	C4 (5 pounds)	1.2 (4/0)	TC2
113.dat	37	TX02037.asc	07/25/02	1406	C4 (5 pounds)	0.3 (1/0)	TC2
114.dat			07/25/02	1543	Calibration		114.dat thru 199.dat are calibration files
199.dat			07/25/02	1648	Calibration		

Table 6. Data quality.

TX 2002 Forest Test
Sensors - Channel numbers

C4 Shots

CERL Rec Num ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
CRREL Rec Num->	39	40	41	42	43	44	60	61	62	63	64	65	66	67	68	93	94	X	95	96	97	98	99
4 P-30-1	X	O	O	O	X	X	O	O	O	X	O	O	O	O	O	O	O	X	O	O	O	O	O
3 P-30-0	X	O	O	O	X	X	O	N	O	X	N	N	O	O	O	O	O	X	O	X	O	O	O
8 P-60-1	X	O	O	O	X	X	O	O	O	X	O	O	O	O	O	O	O	X	O	O	O	O	O
7 P-60-0	X	X	X	X	X	X	O	O	O	X	O	O	O	O	O	O	O	X	O	O	O	O	O
12 P-90-1	X	O	O	O	X	X	O	O	O	X	O	O	O	O	O	O	O	X	O	O	O	O	O
11 P-90-0	X	O	O	O	X	X	O	O	O	X	O	O	O	O	O	O	O	X	O	O	O	O	O
16 P-120-0	X	O	O	O	X	X	O	N	O	X	O	N	O	O	O	O	O	X	O	N	O	O	O
20 P-150-0	X	O	O	O	X	X	O	N	O	X	O	N	O	O	O	O	O	X	O	N	O	O	O
24 P-152T-1	X	O	O	O	X	X	O	N	O	X	O	N	O	O	O	O	O	X	O	N	O	O	O

Shot box TB failed for CERL shots 1, 5, 6, 10. No ascii files.
TB failure for CERL shot 18, no binary or ascii file.

Table 6 (cont'd).

C4 Shots

															3B	4B	5B	6B	7B
CERL Rec Num ->	24	25	26	27	28	29	30	31	32	33	34	35	36	37	43	44	45	46	47
CRREL Rec Num->	100	101	102	103	104	105	106	107	108	109	110	111	112	113	70	71	72	73	74
4 P-30-1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
3 P-30-0	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
8 P-60-1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
7 P-60-0	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
12 P-90-1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
11 P-90-0	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
16 P-120-0	O	O	O	O	N	O	O	O	O	O	O	O	O	O	O	O	O	O	O
20 P-150-0	O	O	O	O	N	O	O	O	O	O	O	O	O	O	O	O	O	O	O
24 P-152T-1	O	O	O	O	N	O	O	O	O	O	O	O	O	O	O	O	O	O	O

O = Good
X = Bad
N = Noisy data - but usable
R = Ringing sensor
C = Crosstalk

BLANK PISTOL SHOTS

CERL Rec Num ->	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
CRREL Rec Num->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
4 P-30-1	O	O	O	O	X	X	X	X	X	X	X	X	X	X	O	O	O	O	O
3 P-30-0	O	O	O	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8 P-60-1	O	O	O	O	X	X	X	X	X	O	O	O	O	O	O	O	O	O	O
7 P-60-0	N	N	N	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12 P-90-1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
11 P-90-0	N	N	N	N	O	O	O	O	O	O	O	O	O	O	N	N	N	N	N
16 P-120-0	X	X	X	X	O	O	O	O	O	N	N	N	N	N	X	X	X	X	X
20 P-150-0	X	X	X	X	N	N	N	N	N	X	X	X	X	X	X	X	X	X	X
24 P-152T-1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

For records 105-119, channels 16, 20 used B&K 4165 microphones.

O = Good
X = Bad
N = Noisy data - but usable
R = Ringing sensor
C = Crosstalk

APPENDIX A: SIGNAL DATA PLOTS

The following signal data plots show the response of the 24 sensors recorded during each test. The plots are normalized so that each channel is the same size. The maximum amplitude is shown in the label for each channel. Figure A1 describes the plot layout, labels and descriptions used for each record made during the test. The plots are normalized so that each channel is the same size. The maximum amplitude is shown in the label for each channel.

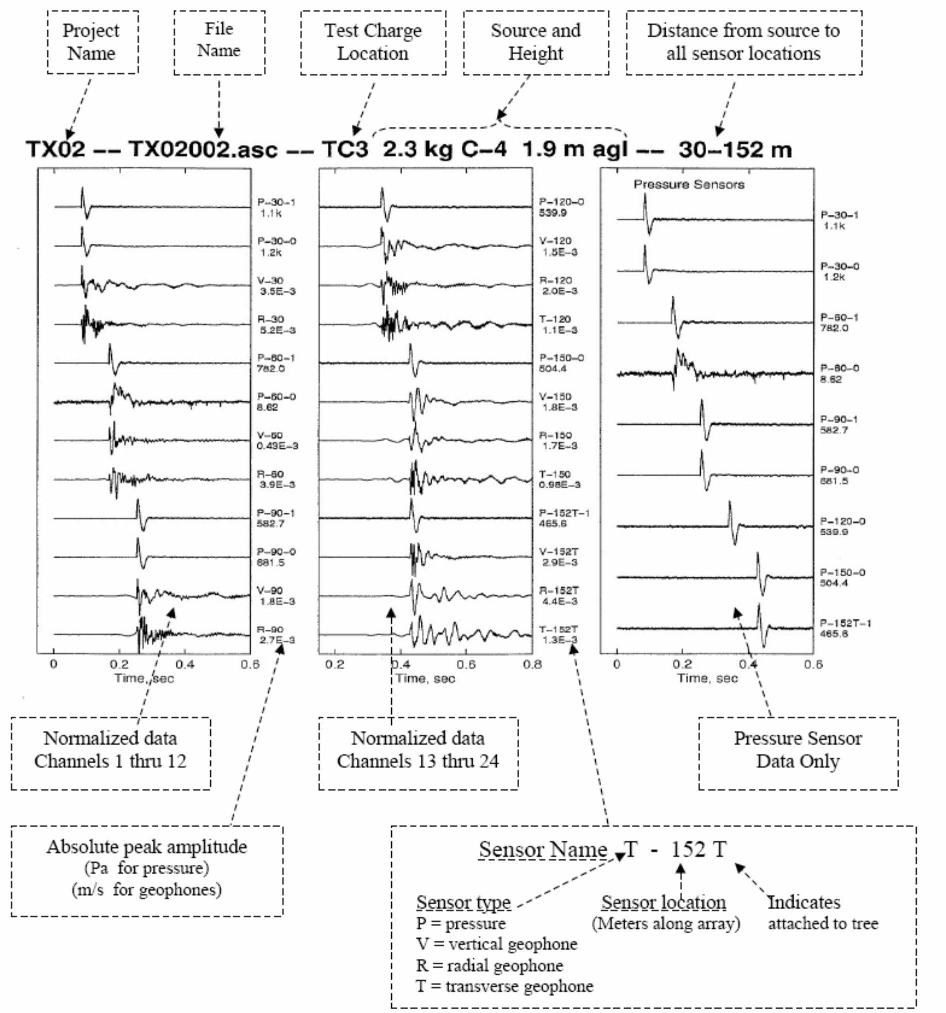
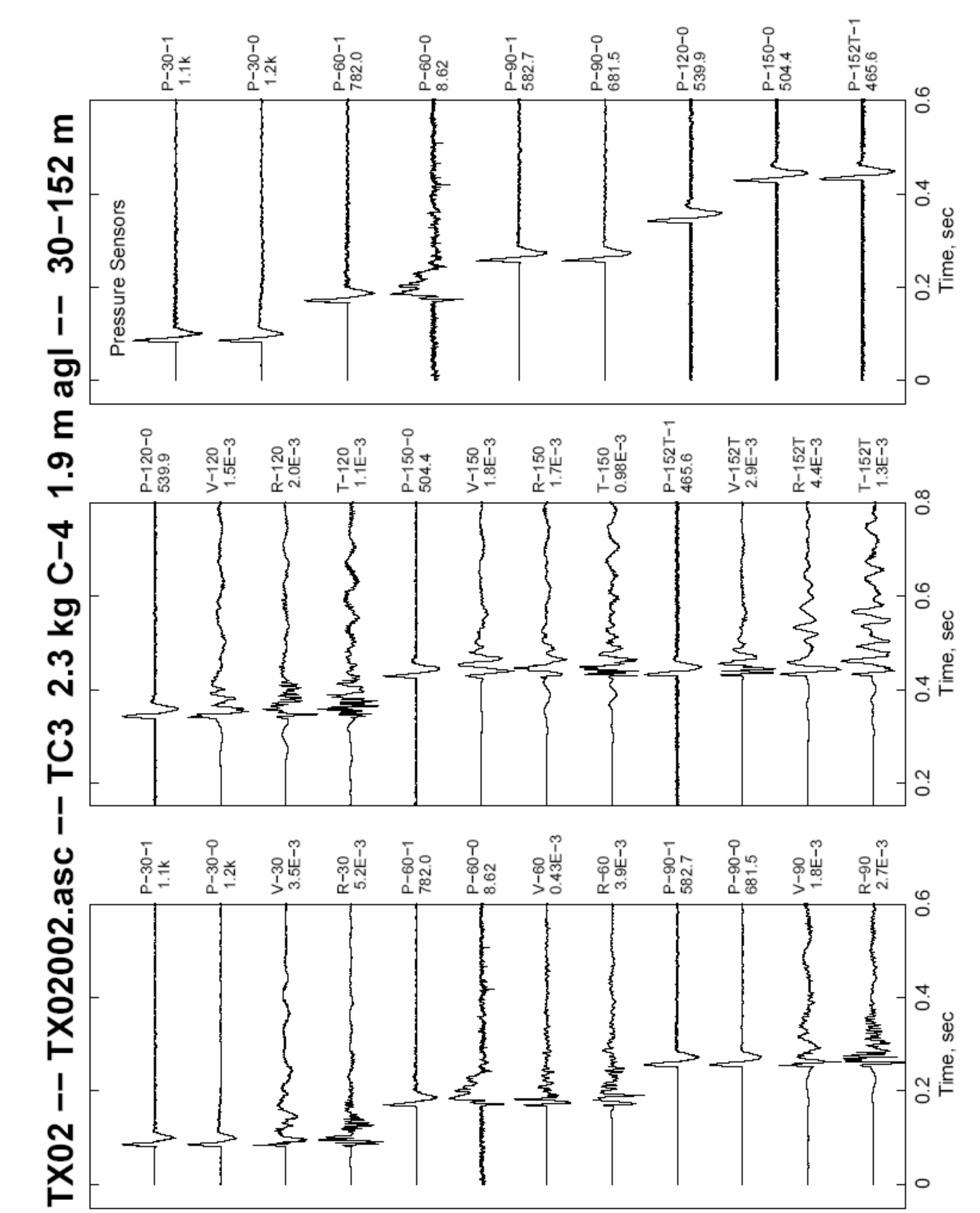
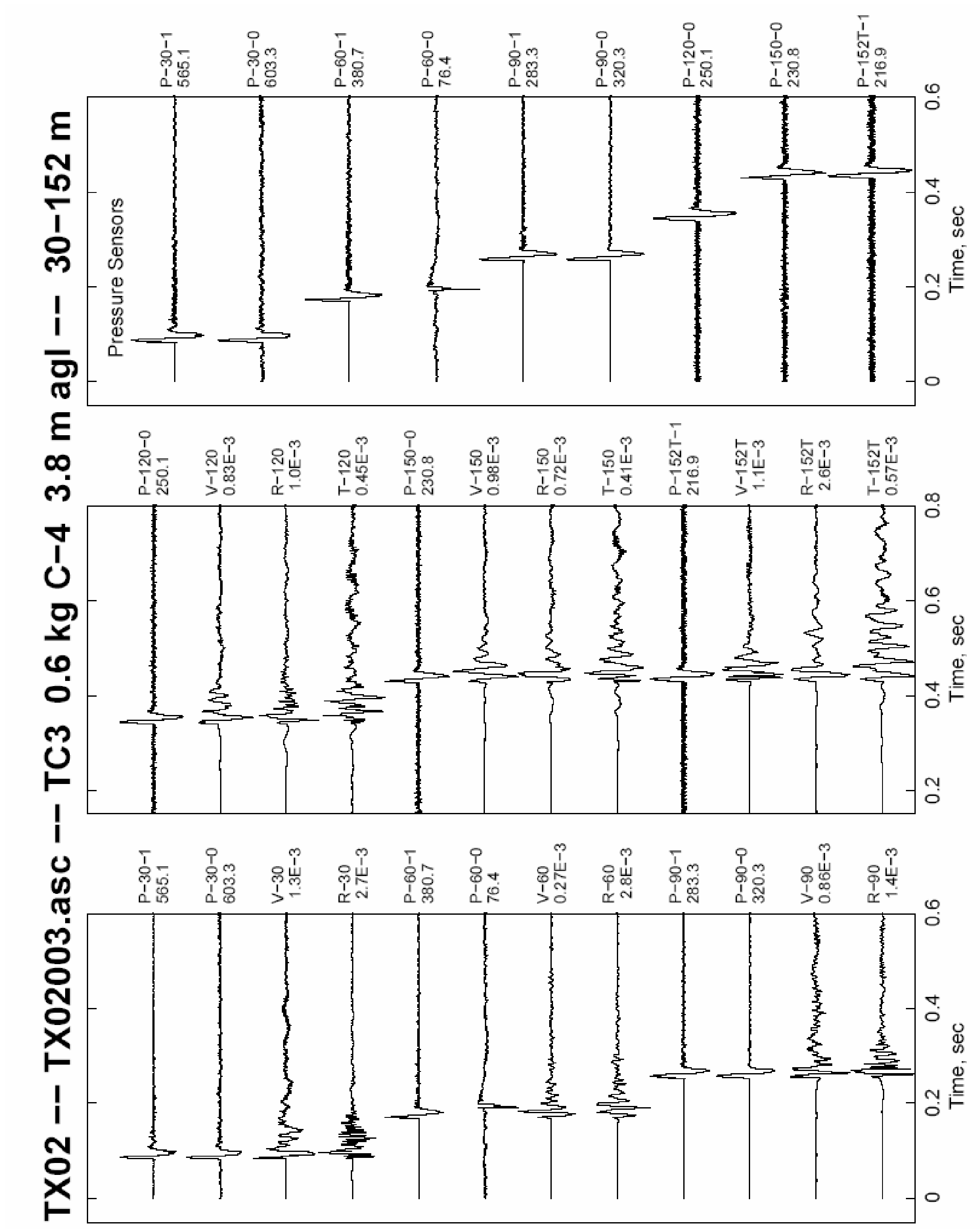
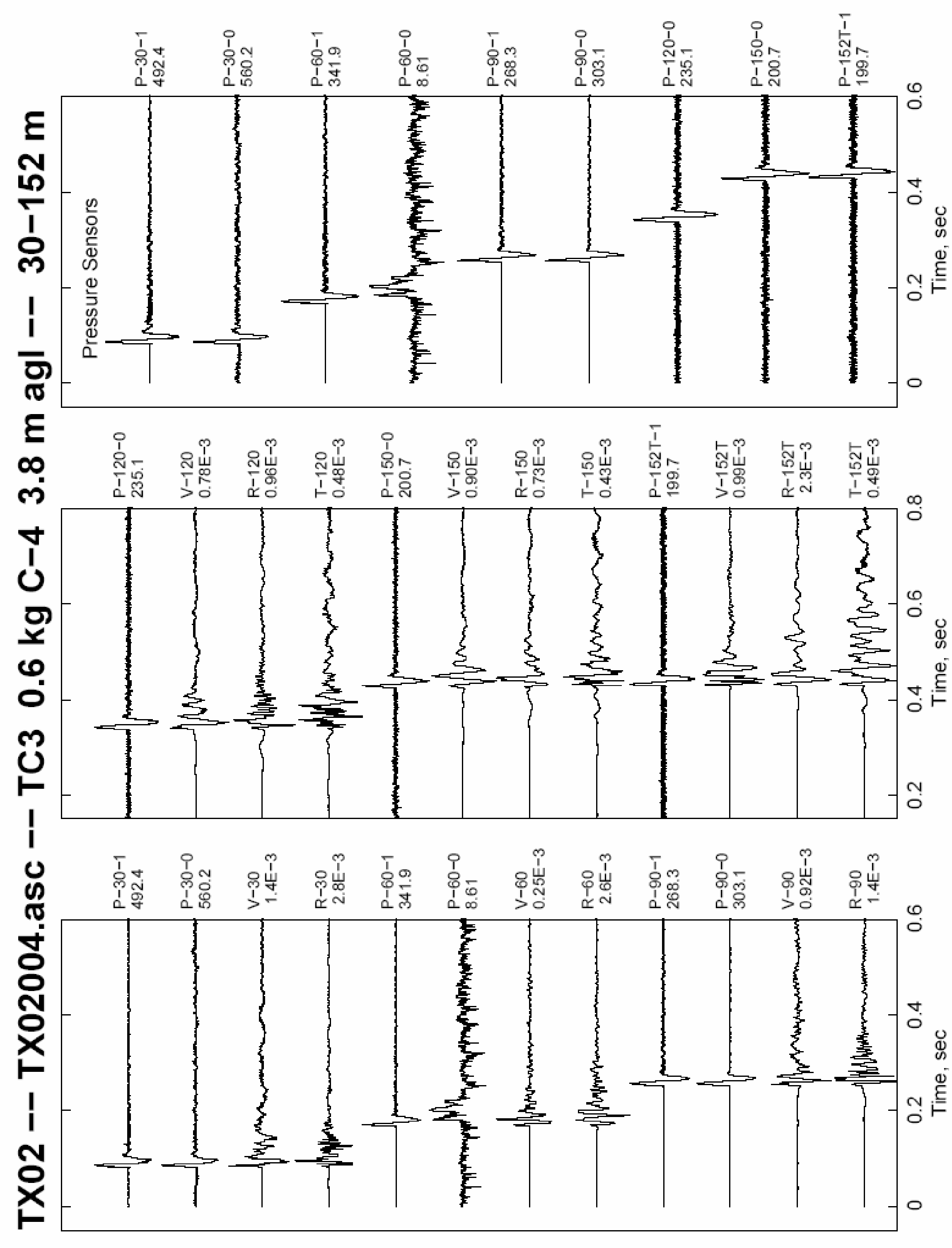


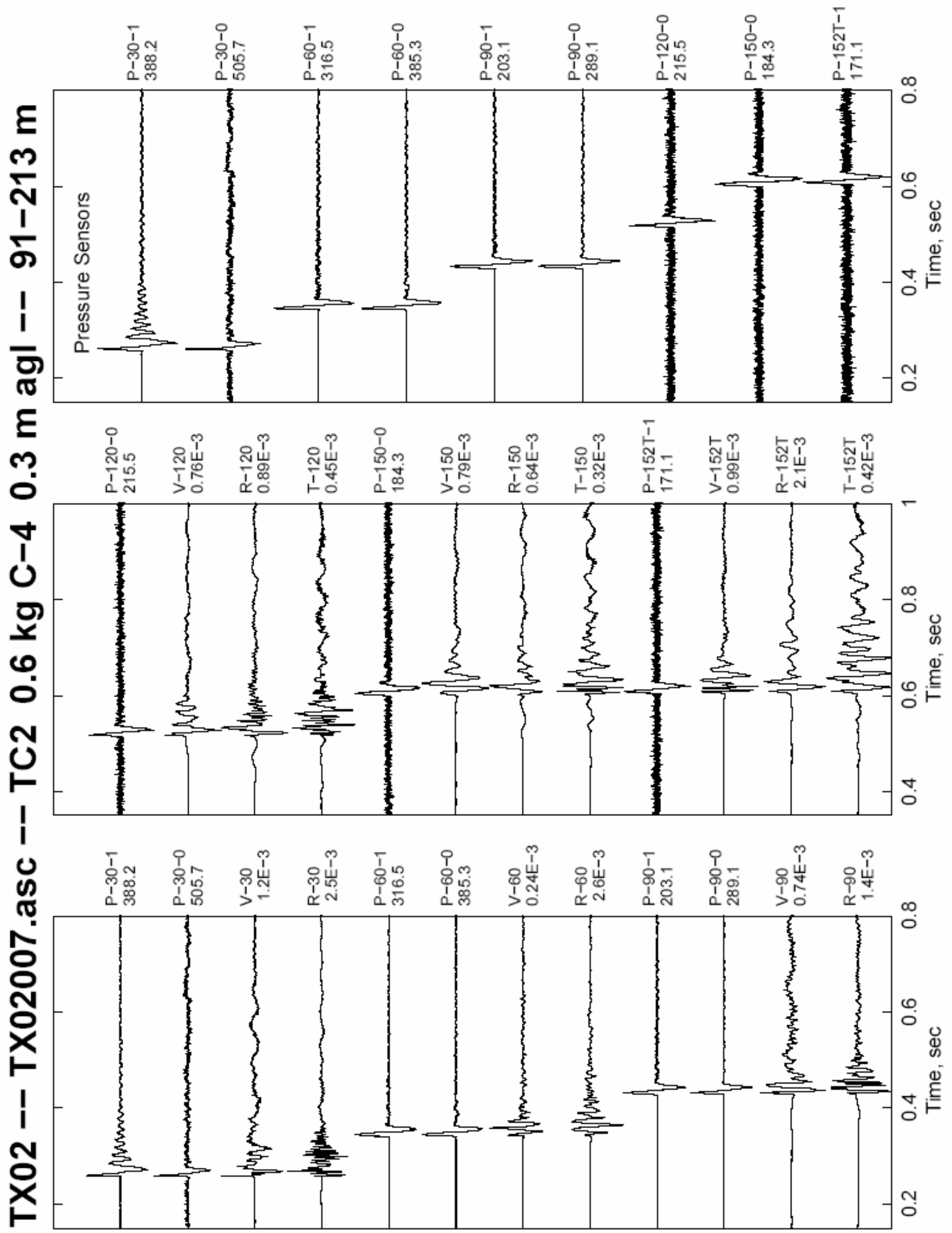
Figure A1. Description of the signal data plots.

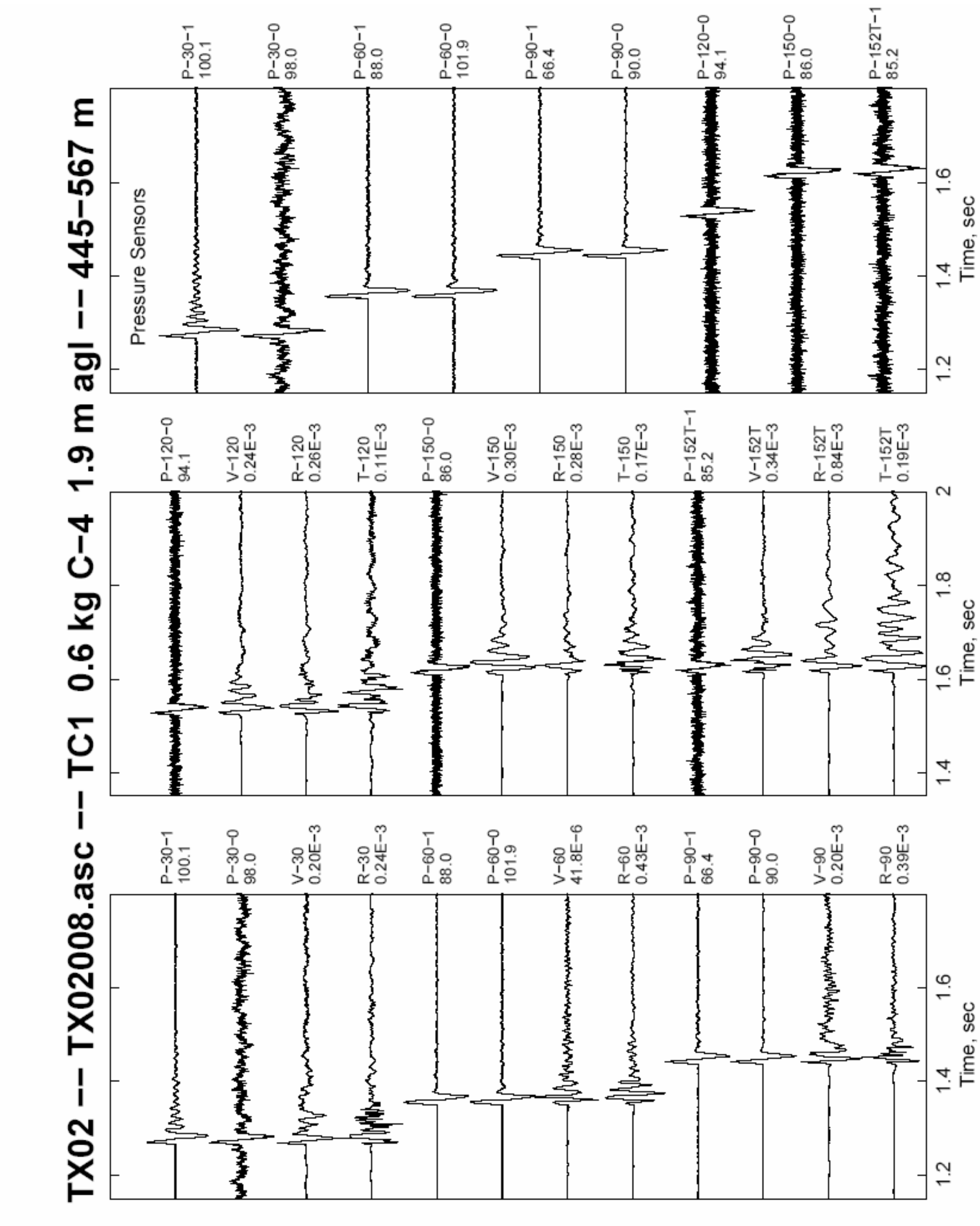

TX02 -- TX02002.asc -- TC3 2.3 kg C-4 1.9 m agl -- 30-152 m
Pressure Sensors
P-30-1 1.1k
P-30-0 1.2k
P-60-1 782.0
P-60-0 8.62
P-90-1 582.7
P-90-0 681.5
P-120-0 539.9
P-150-0 504.4
P-152T-1 465.6
V-120 1.5E-3
R-120 2.0E-3
T-120 1.1E-3
V-150 1.8E-3
R-150 1.7E-3
T-150 0.98E-3
V-152T 2.9E-3
R-152T 4.4E-3
T-152T 1.3E-3
V-30 3.5E-3
R-30 5.2E-3
V-60 0.43E-3
R-60 3.9E-3
V-90 1.8E-3
R-90 2.7E-3
Time, sec

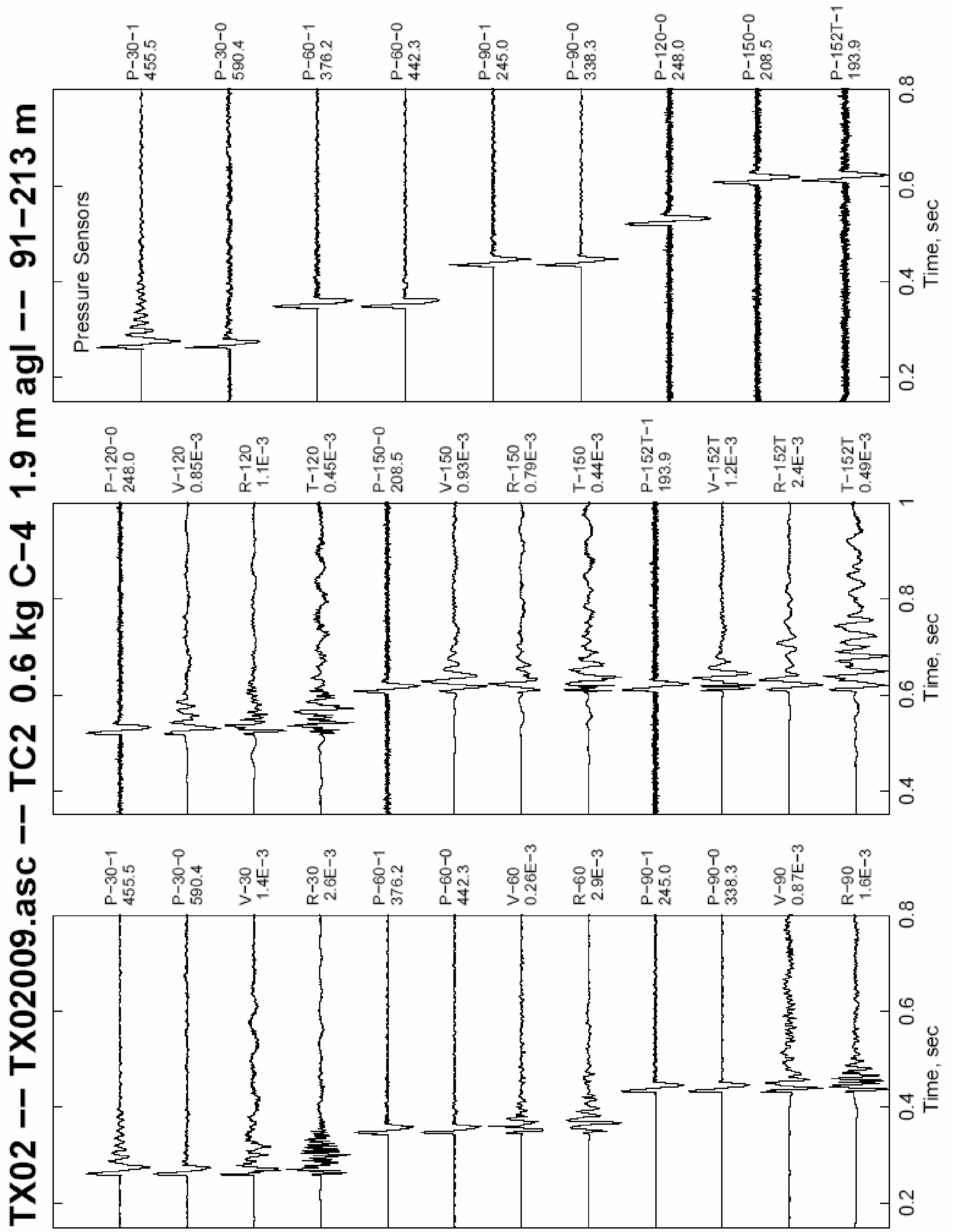


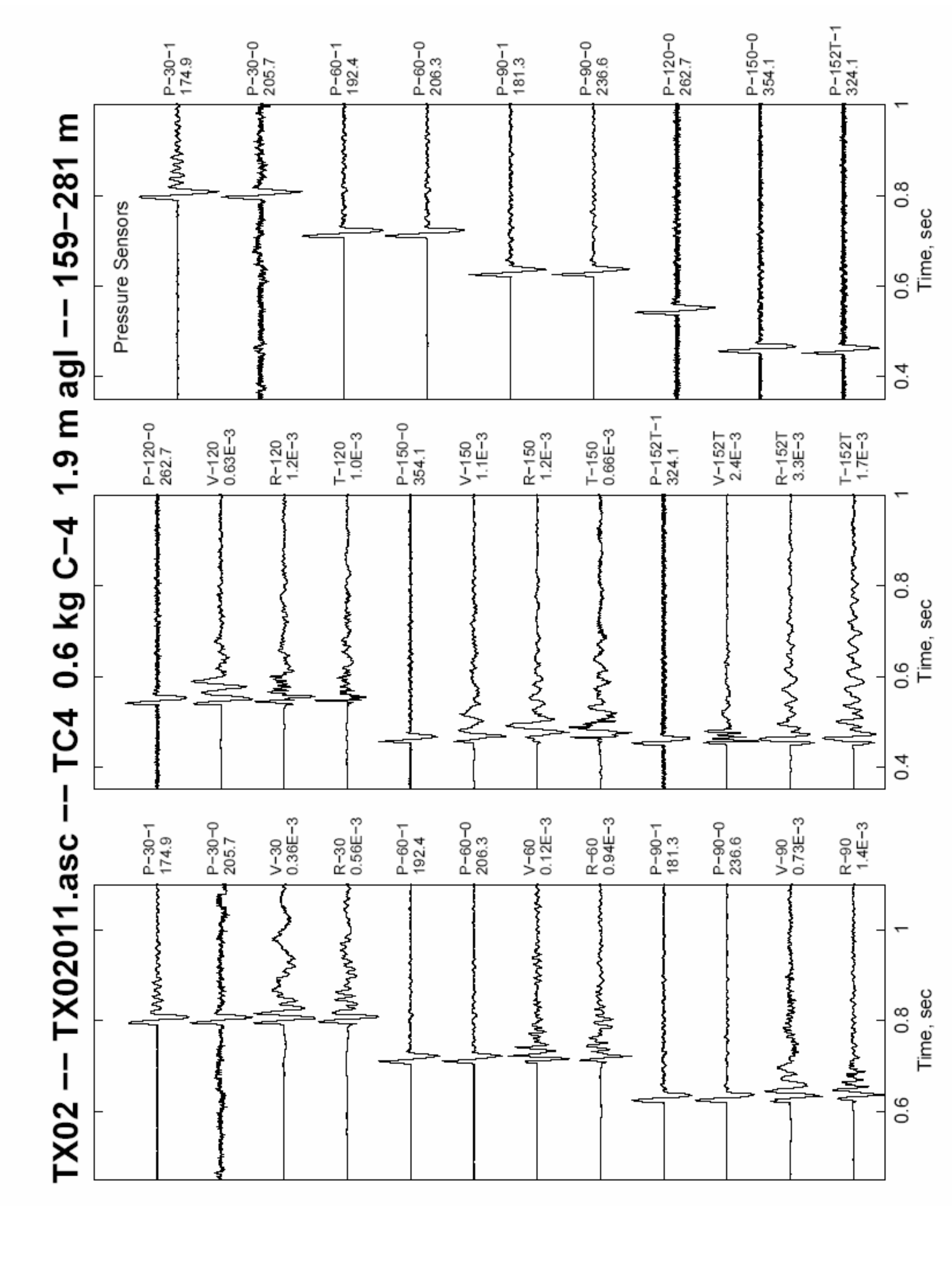
TX02 -- TX02003.asc -- TC3 0.6 kg C-4 3.8 m agl -- 30–152 m
Pressure Sensors
P–30–1 565.1
P–30–0 603.3
V–30 1.3E–3
R–30 2.7E–3
P–60–1 380.7
P–60–0 76.4
V–60 0.27E–3
R–60 2.8E–3
P–90–1 283.3
P–90–0 320.3
V–90 0.86E–3
R–90 1.4E–3
P–120–0 250.1
V–120 0.83E–3
R–120 1.0E–3
T–120 0.45E–3
P–150–0 230.8
V–150 0.98E–3
R–150 0.72E–3
T–150 0.41E–3
P–152T–1 216.9
V–152T 1.1E–3
R–152T 2.6E–3
T–152T 0.57E–3
Time, sec

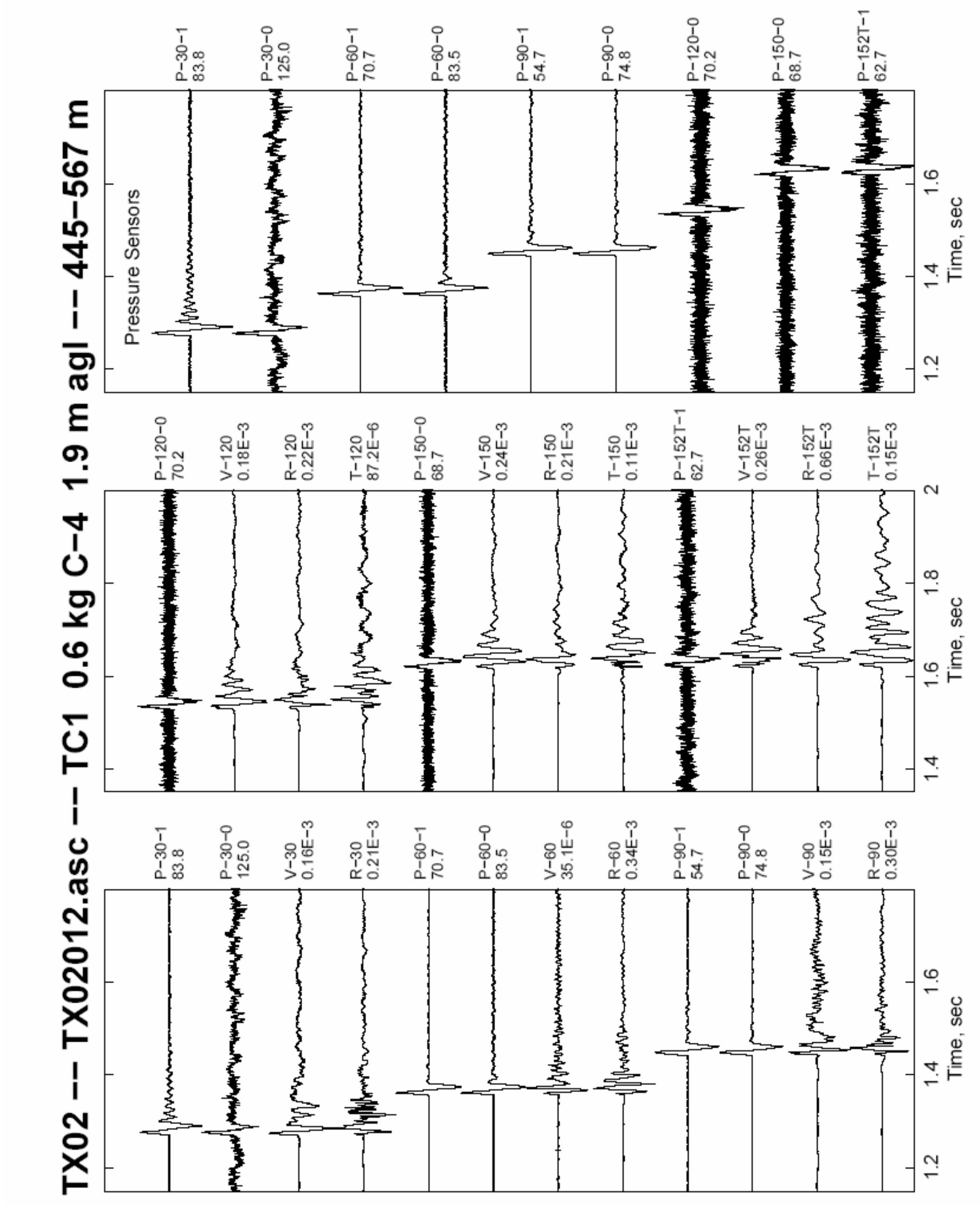

TX02 -- TX02004.asc -- TC3 0.6 kg C-4 3.8 m agl -- 30–152 m
Pressure Sensors
P-30-1 492.4
P-30-0 560.2
V-30 1.4E-3
R-30 2.8E-3
P-60-1 341.9
P-60-0 8.61
V-60 0.25E-3
R-60 2.6E-3
P-90-1 268.3
P-90-0 303.1
V-90 0.92E-3
R-90 1.4E-3
P-120-0 235.1
V-120 0.78E-3
R-120 0.96E-3
T-120 0.48E-3
P-150-0 200.7
V-150 0.90E-3
R-150 0.73E-3
T-150 0.43E-3
P-152T-1 199.7
V-152T 0.99E-3
R-152T 2.3E-3
T-152T 0.49E-3
Time, sec

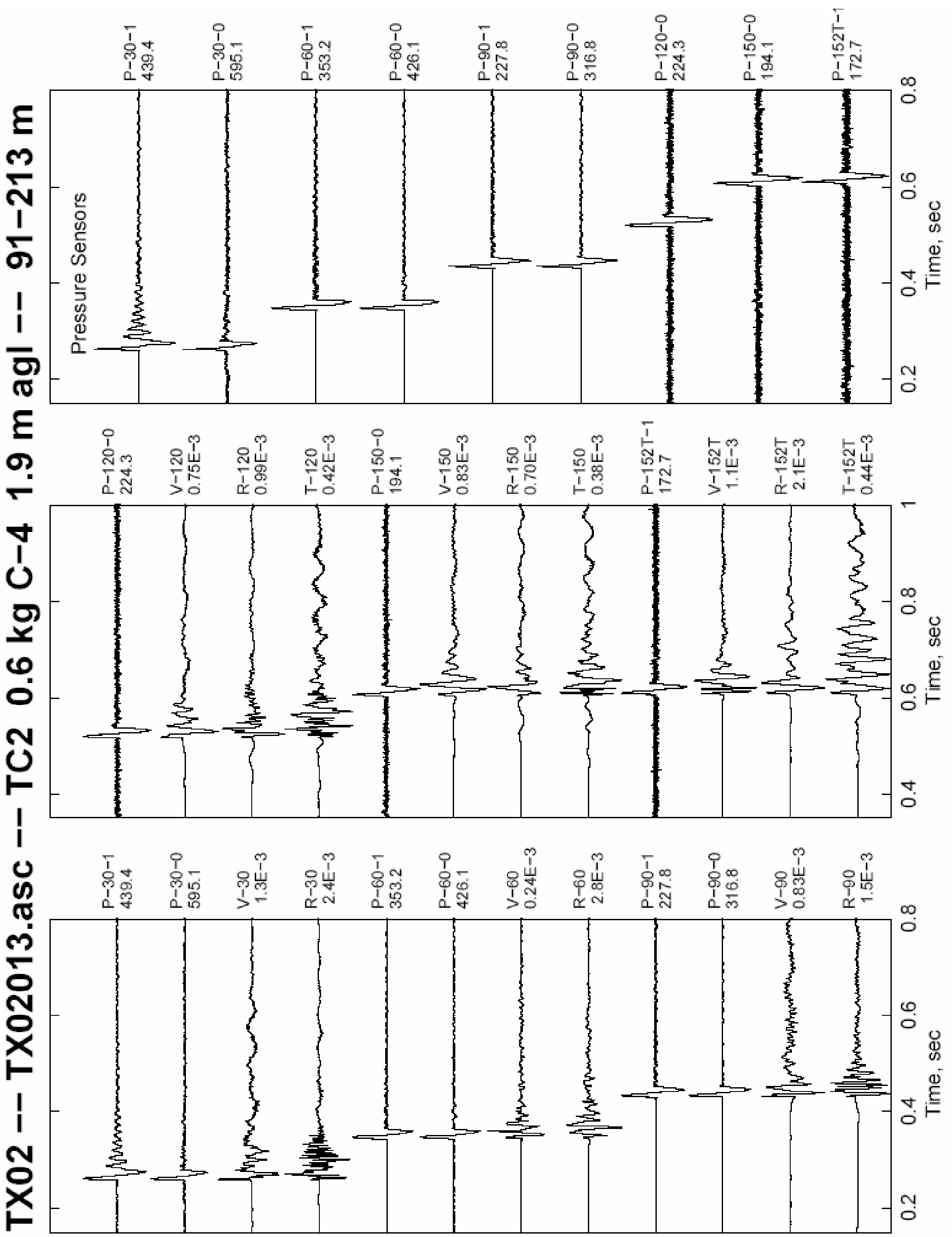

TX02 -- TX02007.asc -- TC2 0.6 kg C-4 0.3 m agl -- 91-213 m
P-30-1 388.2
P-30-0 505.7
V-30 1.2E-3
R-30 2.5E-3
P-60-1 316.5
P-60-0 385.3
V-60 0.24E-3
R-60 2.6E-3
P-90-1 203.1
P-90-0 289.1
V-90 0.74E-3
R-90 1.4E-3
Time, sec
P-120-0 215.5
V-120 0.76E-3
R-120 0.89E-3
T-120 0.45E-3
P-150-0 184.3
V-150 0.79E-3
R-150 0.64E-3
T-150 0.32E-3
P-152T-1 171.1
V-152T 0.99E-3
R-152T 2.1E-3
T-152T 0.42E-3
Time, sec
Pressure Sensors
P-30-1 388.2
P-30-0 505.7
P-60-1 316.5
P-60-0 385.3
P-90-1 203.1
P-90-0 289.1
P-120-0 215.5
P-150-0 184.3
P-152T-1 171.1
Time, sec

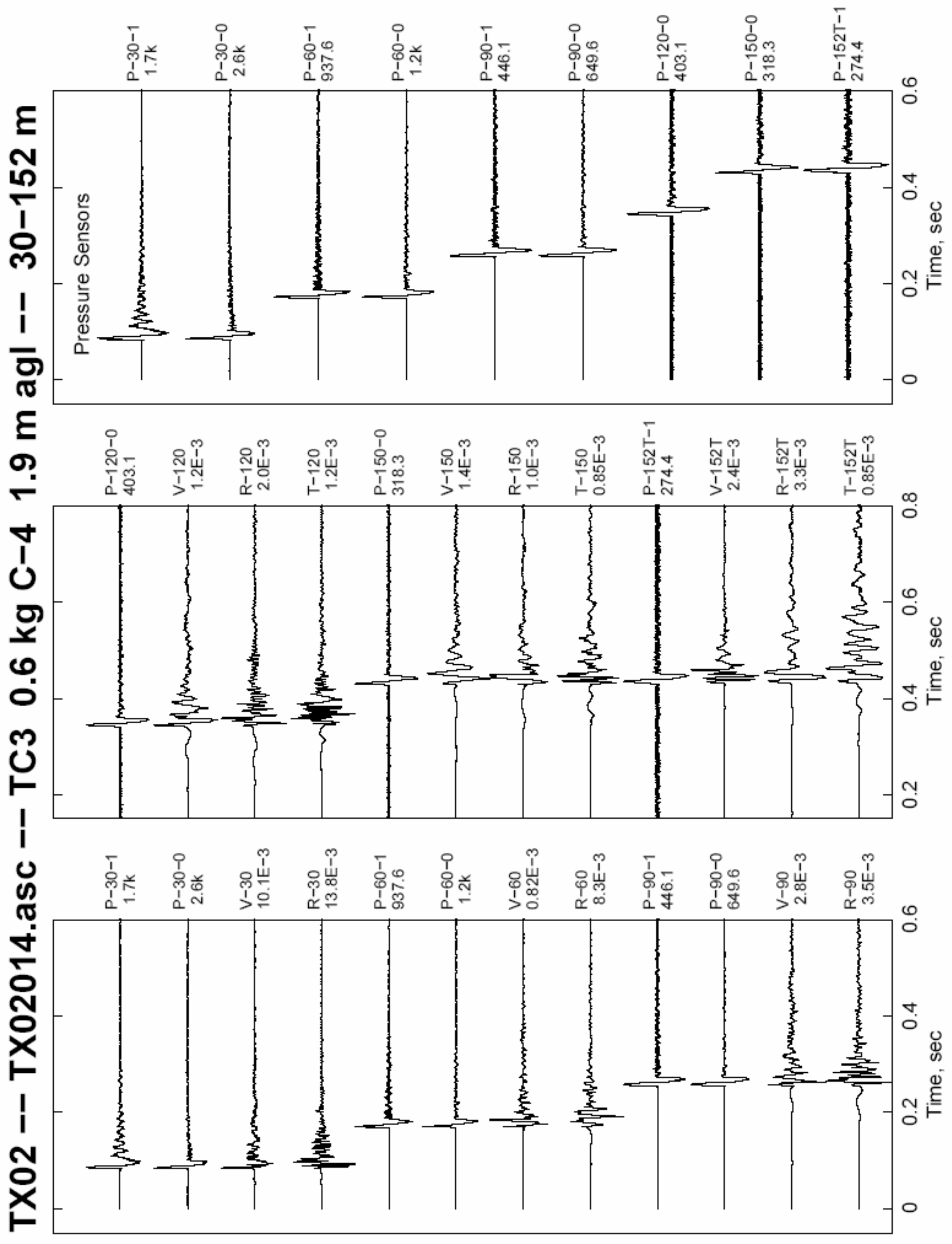

TX02 -- TX02008.asc -- TC1 0.6 kg C-4 1.9 m agl -- 445-567 m
P-30-1 100.1
P-30-0 98.0
V-30 0.20E-3
R-30 0.24E-3
P-60-1 88.0
P-60-0 101.9
V-60 41.8E-6
R-60 0.43E-3
P-90-1 66.4
P-90-0 90.0
V-90 0.20E-3
R-90 0.39E-3
Time, sec
P-120-0 94.1
V-120 0.24E-3
R-120 0.26E-3
T-120 0.11E-3
P-150-0 86.0
V-150 0.30E-3
R-150 0.28E-3
T-150 0.17E-3
P-152T-1 85.2
V-152T 0.34E-3
R-152T 0.84E-3
T-152T 0.19E-3
Time, sec
Pressure Sensors
P-30-1 100.1
P-30-0 98.0
P-60-1 88.0
P-60-0 101.9
P-90-1 66.4
P-90-0 90.0
P-120-0 94.1
P-150-0 86.0
P-152T-1 85.2
Time, sec

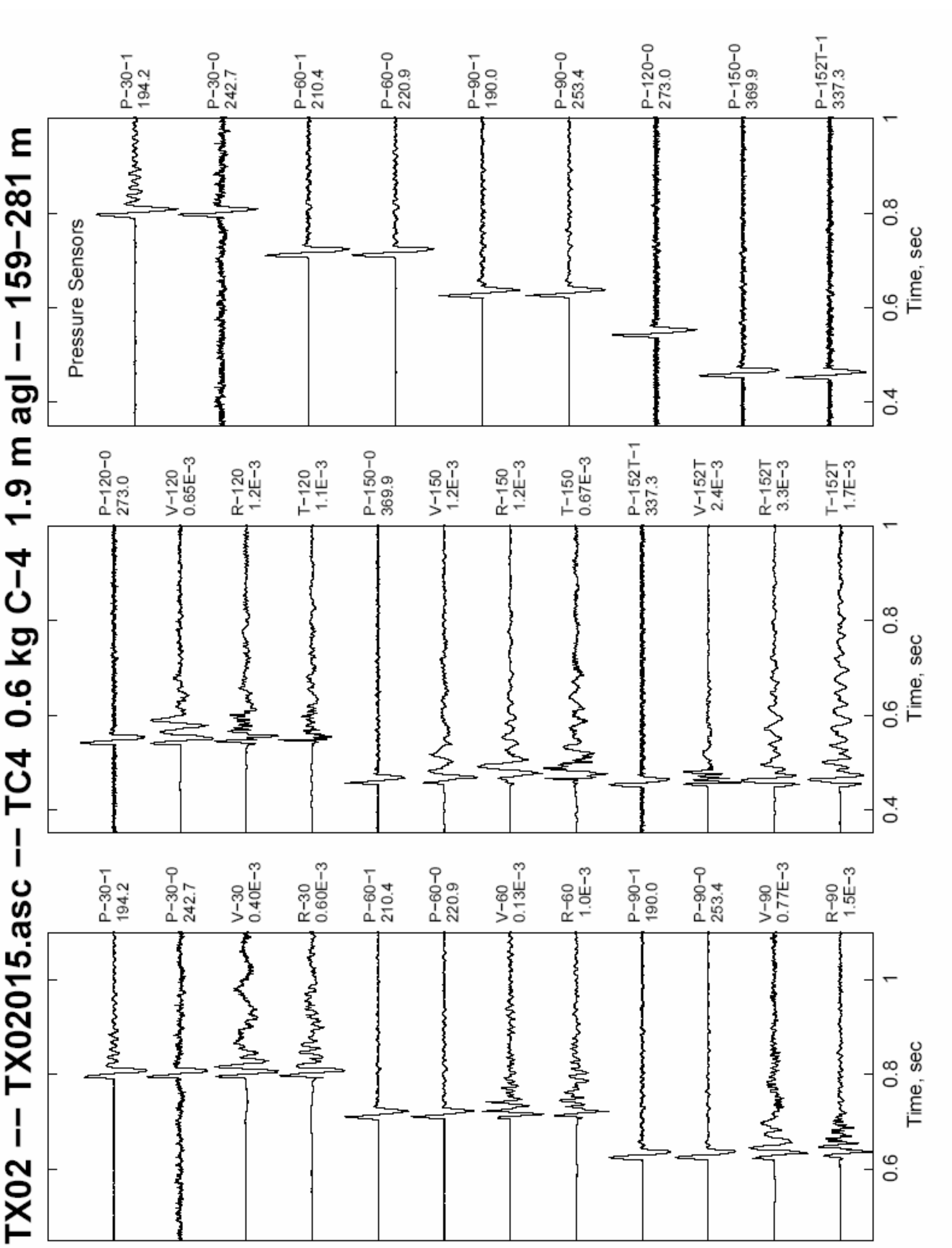

TX02 -- TX02009.asc -- TC2 0.6 kg C-4 1.9 m agl -- 91-213 m
P-30-1 455.5
P-30-0 590.4
V-30 1.4E-3
R-30 2.6E-3
P-60-1 376.2
P-60-0 442.3
V-60 0.26E-3
R-60 2.9E-3
P-90-1 245.0
P-90-0 338.3
V-90 0.87E-3
R-90 1.6E-3
Time, sec
P-120-0 248.0
V-120 0.85E-3
R-120 1.1E-3
T-120 0.45E-3
P-150-0 208.5
V-150 0.93E-3
R-150 0.79E-3
T-150 0.44E-3
P-152T-1 193.9
V-152T 1.2E-3
R-152T 2.4E-3
T-152T 0.49E-3
Time, sec
Pressure Sensors
P-30-1 455.5
P-30-0 590.4
P-60-1 376.2
P-60-0 442.3
P-90-1 245.0
P-90-0 338.3
P-120-0 248.0
P-150-0 208.5
P-152T-1 193.9
Time, sec

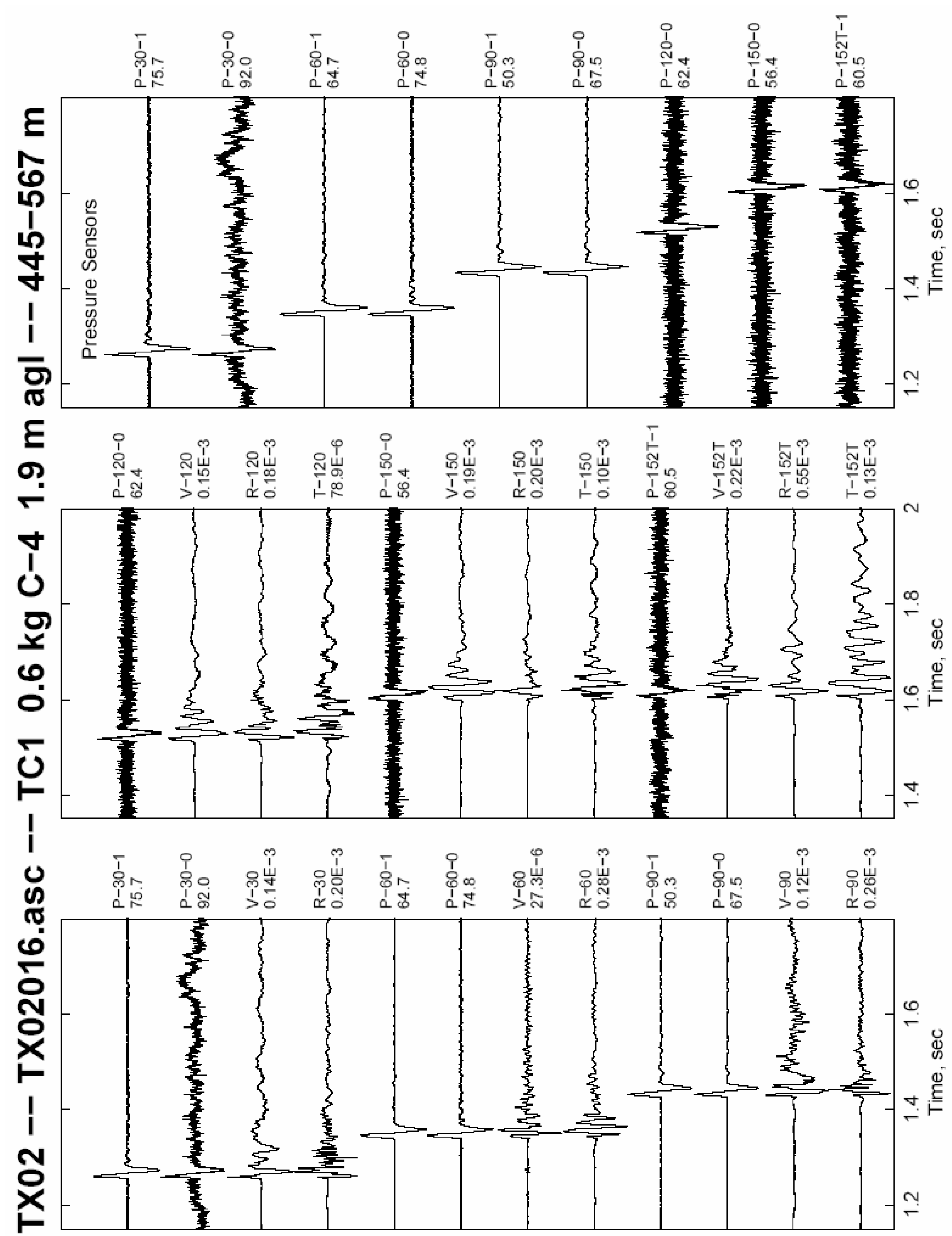

TX02 -- TX02011.asc -- TC4 0.6 kg C-4 1.9 m agl -- 159-281 m
Pressure Sensors
P-30-1 174.9
P-30-0 205.7
P-60-1 192.4
P-60-0 206.3
P-90-1 181.3
P-90-0 236.6
P-120-0 262.7
P-150-0 354.1
P-152T-1 324.1
V-120 0.63E-3
R-120 1.2E-3
T-120 1.0E-3
V-150 1.1E-3
R-150 1.2E-3
T-150 0.66E-3
V-152T 2.4E-3
R-152T 3.3E-3
T-152T 1.7E-3
V-30 0.36E-3
R-30 0.56E-3
V-60 0.12E-3
R-60 0.94E-3
V-90 0.73E-3
R-90 1.4E-3
Time, sec

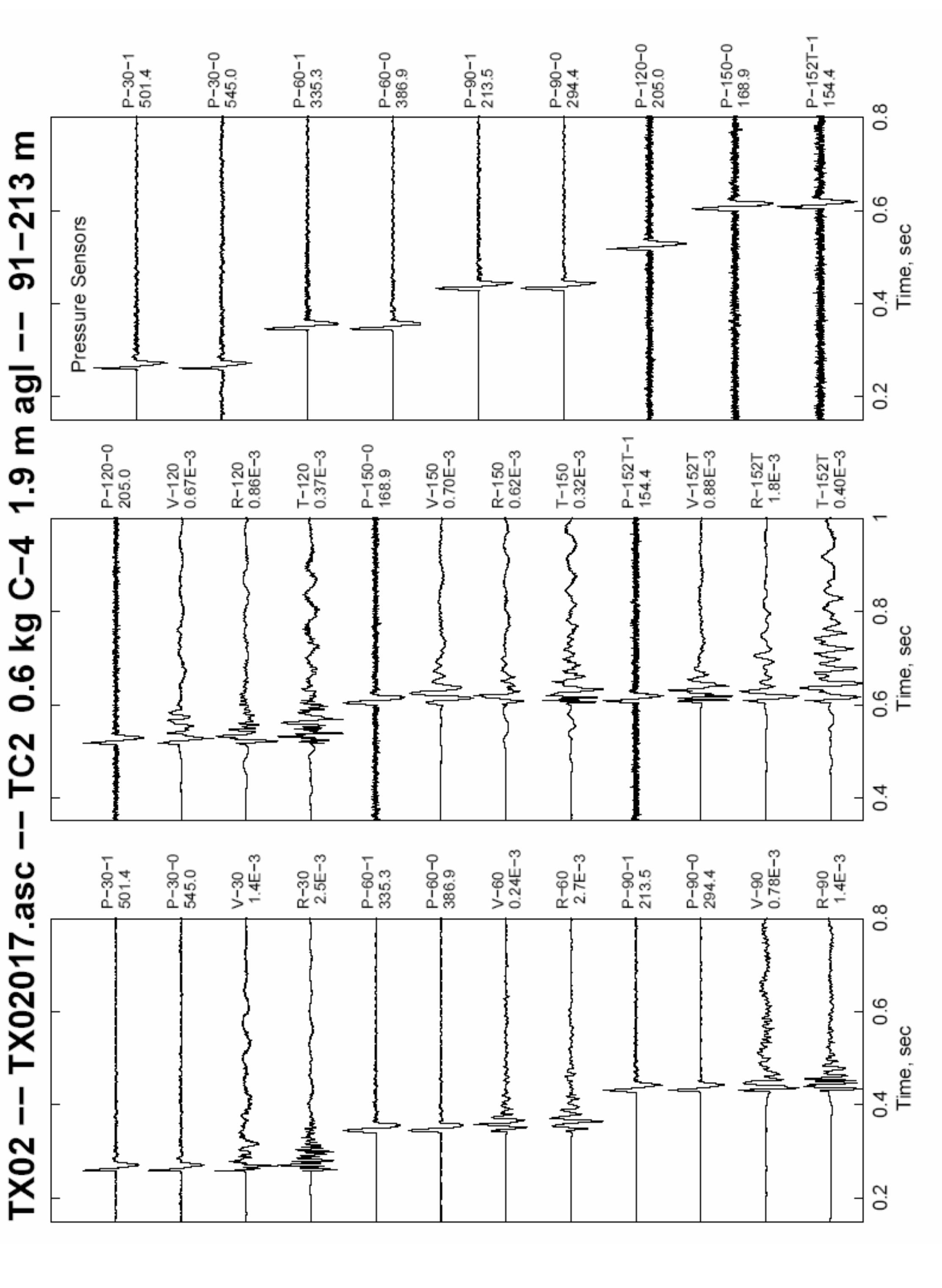

TX02 -- TX02012.asc -- TC1 0.6 kg C-4 1.9 m agl -- 445-567 m
Pressure Sensors
P-30-1 83.8
P-30-0 125.0
P-60-1 70.7
P-60-0 83.5
P-90-1 54.7
P-90-0 74.8
P-120-0 70.2
P-150-0 68.7
P-152T-1 62.7
V-120 0.18E-3
R-120 0.22E-3
T-120 87.2E-6
V-150 0.24E-3
R-150 0.21E-3
T-150 0.11E-3
V-152T 0.26E-3
R-152T 0.66E-3
T-152T 0.15E-3
V-30 0.16E-3
R-30 0.21E-3
V-60 35.1E-6
R-60 0.34E-3
V-90 0.15E-3
R-90 0.30E-3
Time, sec

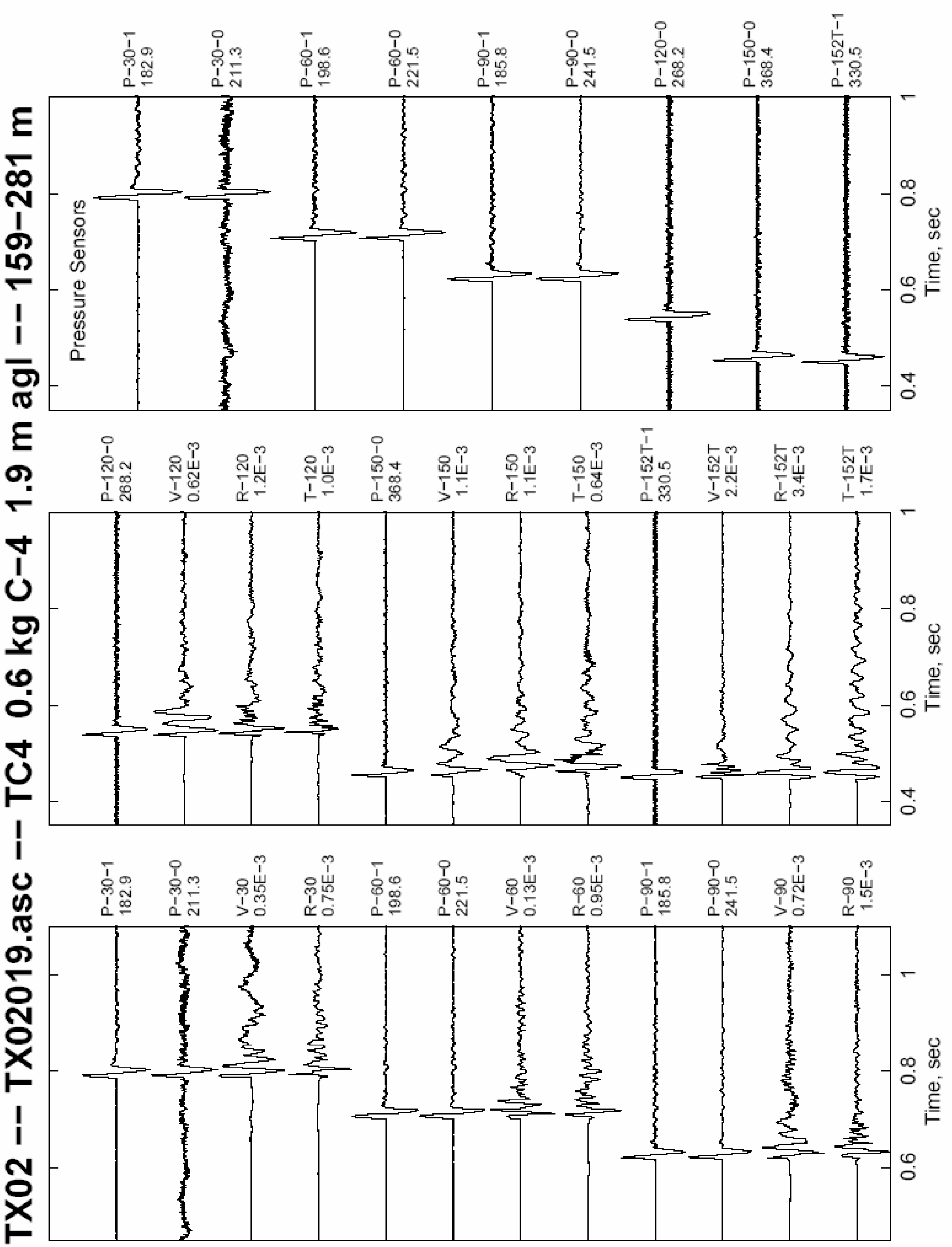

TX02 -- TX02013.asc -- TC2 0.6 kg C-4 1.9 m agl -- 91-213 m
Pressure Sensors
P-30-1 439.4
P-30-0 595.1
V-30 1.3E-3
R-30 2.4E-3
P-60-1 353.2
P-60-0 426.1
V-60 0.24E-3
R-60 2.8E-3
P-90-1 227.8
P-90-0 316.8
V-90 0.83E-3
R-90 1.5E-3
P-120-0 224.3
V-120 0.75E-3
R-120 0.99E-3
T-120 0.42E-3
P-150-0 194.1
V-150 0.83E-3
R-150 0.70E-3
T-150 0.38E-3
P-152T-1 172.7
V-152T 1.1E-3
R-152T 2.1E-3
T-152T 0.44E-3
Time, sec
0.2
0.4
0.6
0.8
1

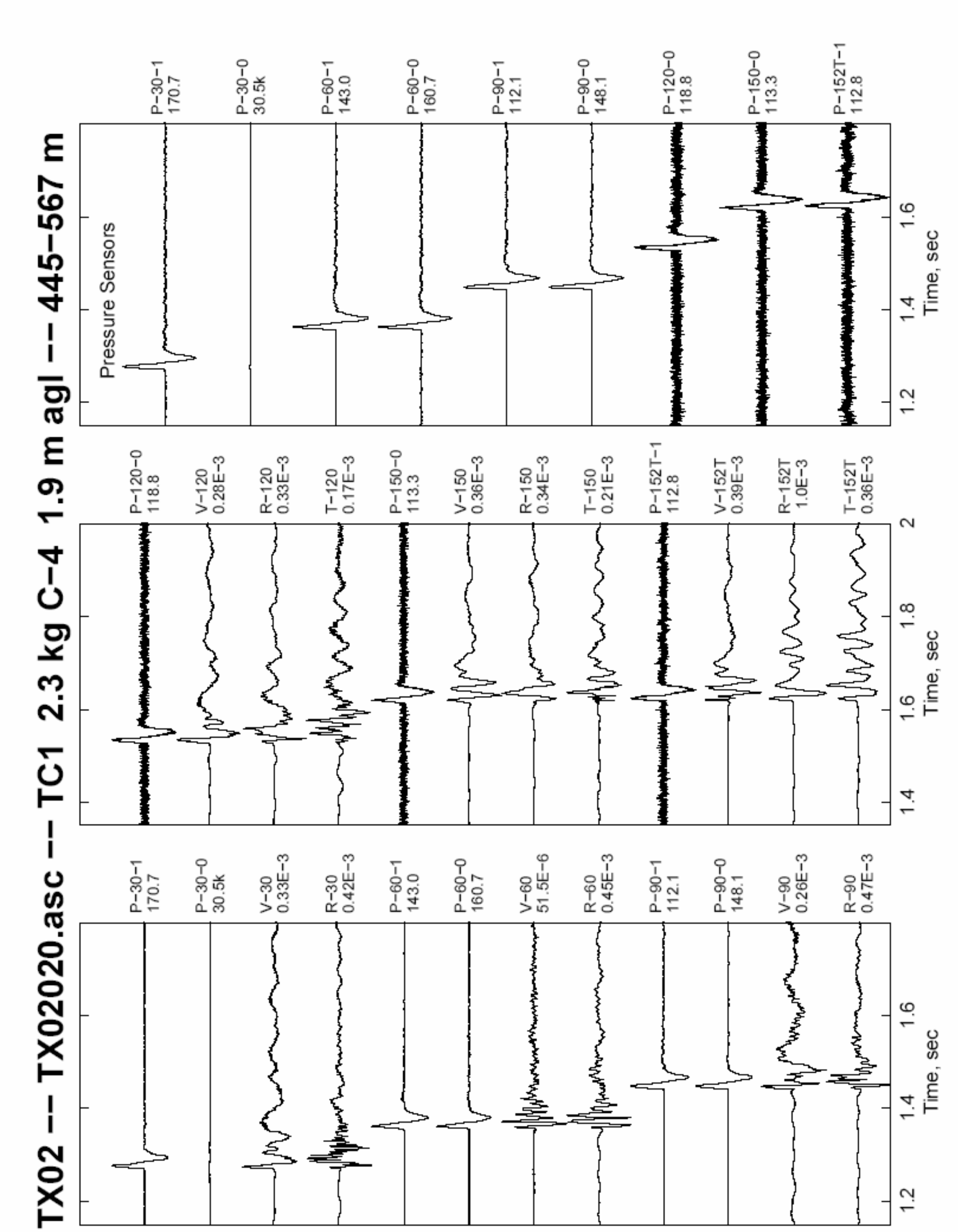

TX02 -- TX02014.asc -- TC3 0.6 kg C-4 1.9 m agl -- 30-152 m
P-30-1 1.7k
P-30-0 2.6k
V-30 10.1E-3
R-30 13.8E-3
P-60-1 937.6
P-60-0 1.2k
V-60 0.82E-3
R-60 8.3E-3
P-90-1 446.1
P-90-0 649.6
V-90 2.8E-3
R-90 3.5E-3
Time, sec
P-120-0 403.1
V-120 1.2E-3
R-120 2.0E-3
T-120 1.2E-3
P-150-0 318.3
V-150 1.4E-3
R-150 1.0E-3
T-150 0.85E-3
P-152T-1 274.4
V-152T 2.4E-3
R-152T 3.3E-3
T-152T 0.85E-3
Time, sec
Pressure Sensors
P-30-1 1.7k
P-30-0 2.6k
P-60-1 937.6
P-60-0 1.2k
P-90-1 446.1
P-90-0 649.6
P-120-0 403.1
P-150-0 318.3
P-152T-1 274.4
Time, sec

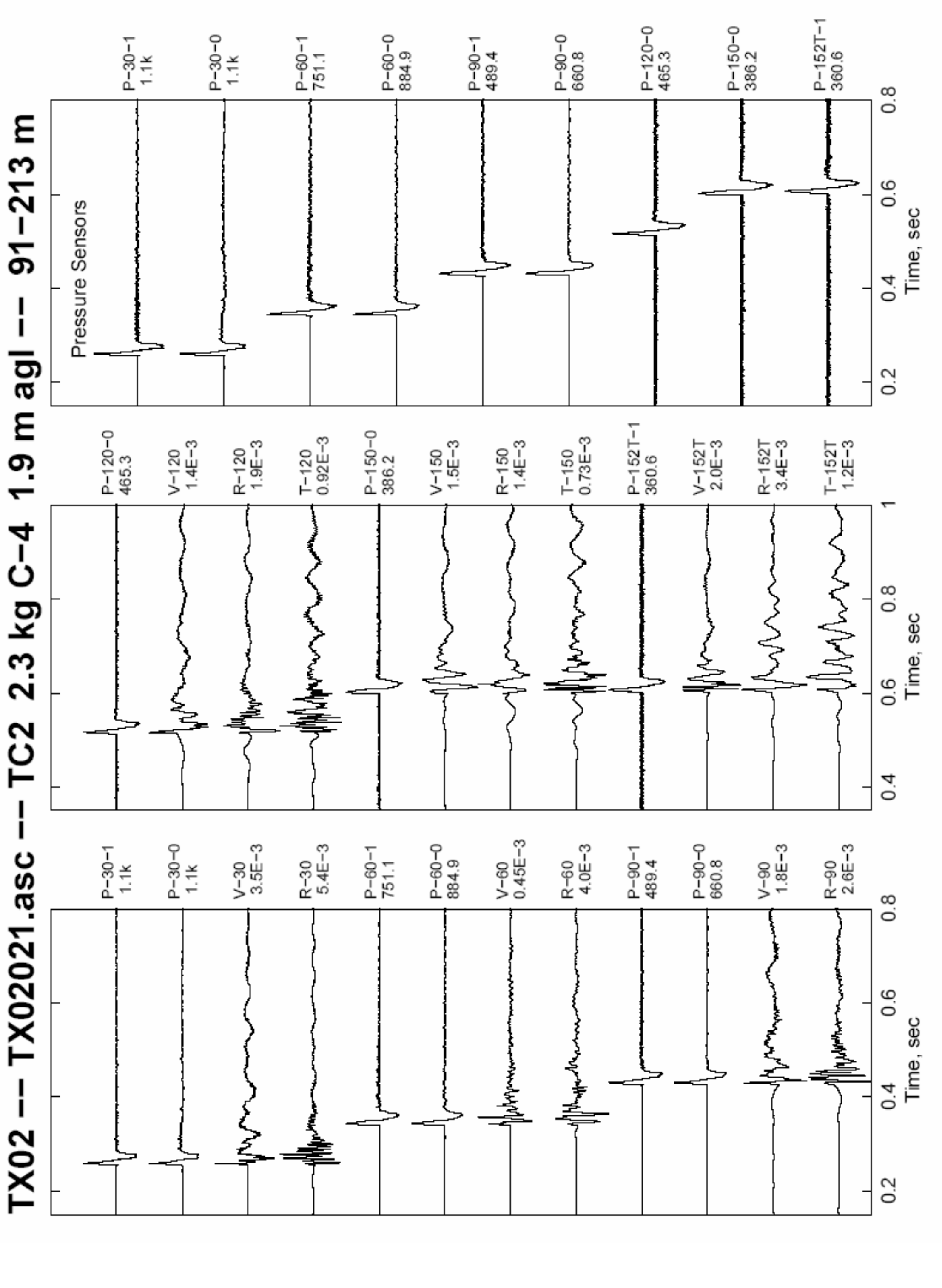

TX02 -- TX02015.asc -- TC4 0.6 kg C-4 1.9 m agl -- 159–281 m
Pressure Sensors
P–30–1 194.2
P–30–0 242.7
P–60–1 210.4
P–60–0 220.9
P–90–1 190.0
P–90–0 253.4
P–120–0 273.0
P–150–0 369.9
P–152T–1 337.3
V–120 0.65E–3
R–120 1.2E–3
T–120 1.1E–3
V–150 1.2E–3
R–150 1.2E–3
T–150 0.67E–3
V–152T 2.4E–3
R–152T 3.3E–3
T–152T 1.7E–3
V–30 0.40E–3
R–30 0.60E–3
V–60 0.13E–3
R–60 1.0E–3
V–90 0.77E–3
R–90 1.5E–3
Time, sec

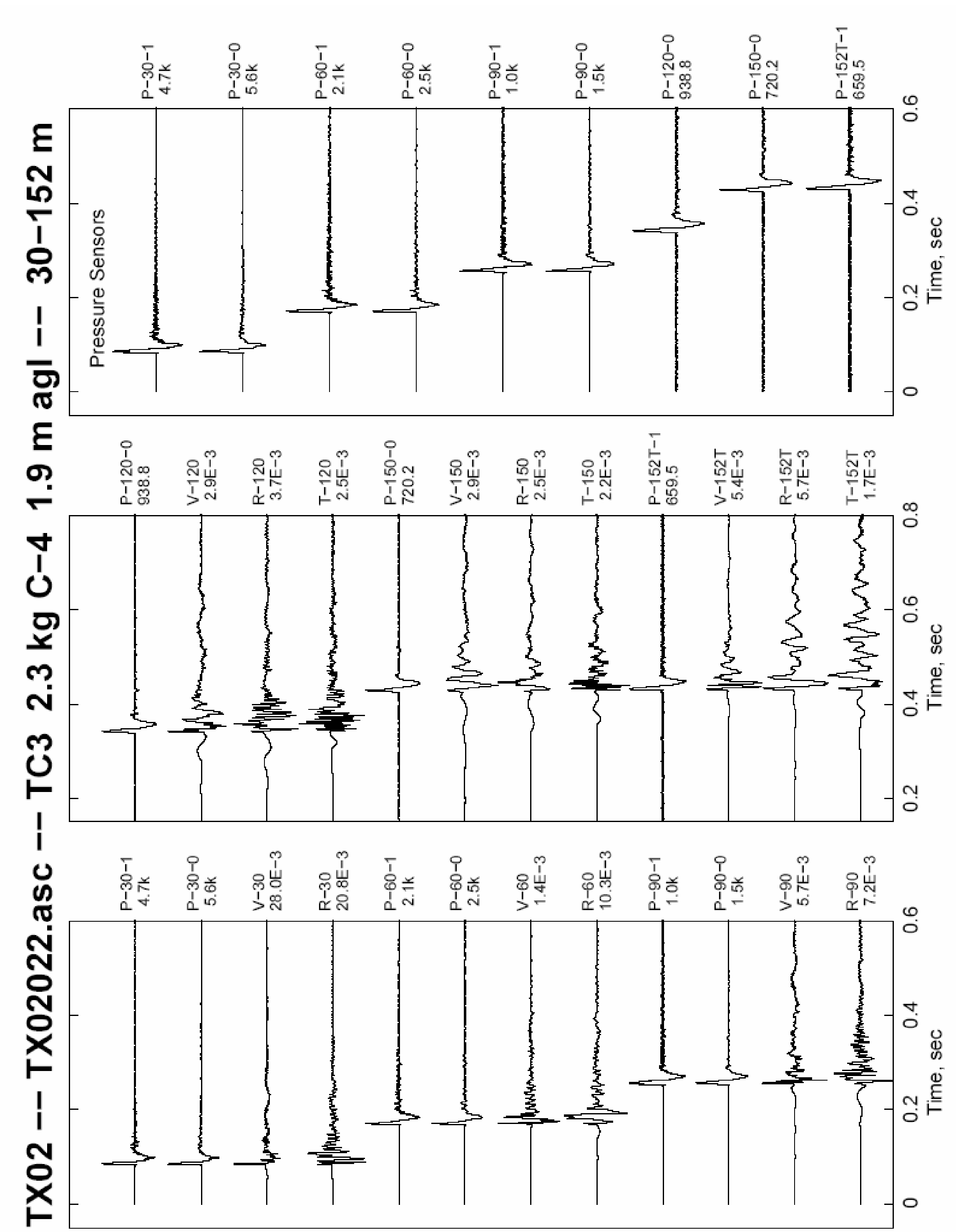

TX02 -- TX02016.asc -- TC1 0.6 kg C-4 1.9 m agl -- 445-567 m
Pressure Sensors
P-30-1 75.7
P-30-0 92.0
V-30 0.14E-3
R-30 0.20E-3
P-60-1 64.7
P-60-0 74.8
V-60 27.3E-6
R-60 0.28E-3
P-90-1 50.3
P-90-0 67.5
V-90 0.12E-3
R-90 0.26E-3
P-120-0 62.4
V-120 0.15E-3
R-120 0.18E-3
T-120 78.9E-6
P-150-0 56.4
V-150 0.19E-3
R-150 0.20E-3
T-150 0.10E-3
P-152T-1 60.5
V-152T 0.22E-3
R-152T 0.55E-3
T-152T 0.13E-3
Time, sec
1.2
1.4
1.6
1.8
2

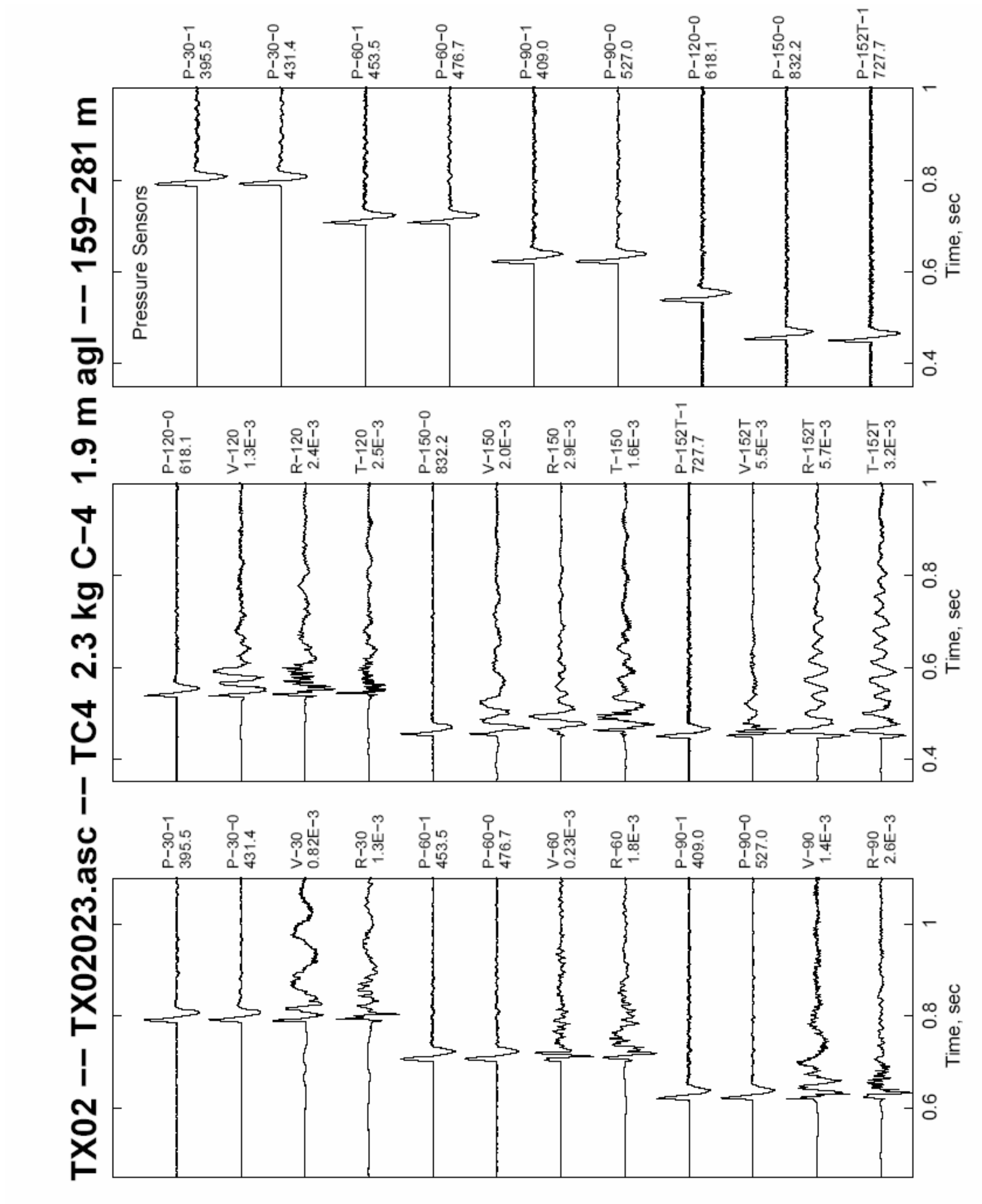

TX02 -- TX02017.asc -- TC2 0.6 kg C-4 1.9 m agl -- 91-213 m
P-30-1 501.4
P-30-0 545.0
V-30 1.4E-3
R-30 2.5E-3
P-60-1 335.3
P-60-0 386.9
V-60 0.24E-3
R-60 2.7E-3
P-90-1 213.5
P-90-0 294.4
V-90 0.78E-3
R-90 1.4E-3
0.2
0.4
0.6
0.8
Time, sec
P-120-0 205.0
V-120 0.67E-3
R-120 0.86E-3
T-120 0.37E-3
P-150-0 168.9
V-150 0.70E-3
R-150 0.62E-3
T-150 0.32E-3
P-152T-1 154.4
V-152T 0.88E-3
R-152T 1.8E-3
T-152T 0.40E-3
0.4
0.6
0.8
1
Time, sec
Pressure Sensors
P-30-1 501.4
P-30-0 545.0
P-60-1 335.3
P-60-0 386.9
P-90-1 213.5
P-90-0 294.4
P-120-0 205.0
P-150-0 168.9
P-152T-1 154.4
0.2
0.4
0.6
0.8
Time, sec


TX02 -- TX02019.asc -- TC4 0.6 kg C-4 1.9 m agl -- 159-281 m
Pressure Sensors
P-30-1 182.9
P-30-0 211.3
V-30 0.35E-3
R-30 0.75E-3
P-60-1 198.6
P-60-0 221.5
V-60 0.13E-3
R-60 0.95E-3
P-90-1 185.8
P-90-0 241.5
V-90 0.72E-3
R-90 1.5E-3
P-120-0 268.2
V-120 0.62E-3
R-120 1.2E-3
T-120 1.0E-3
P-150-0 368.4
V-150 1.1E-3
R-150 1.1E-3
T-150 0.64E-3
P-152T-1 330.5
V-152T 2.2E-3
R-152T 3.4E-3
T-152T 1.7E-3
Time, sec

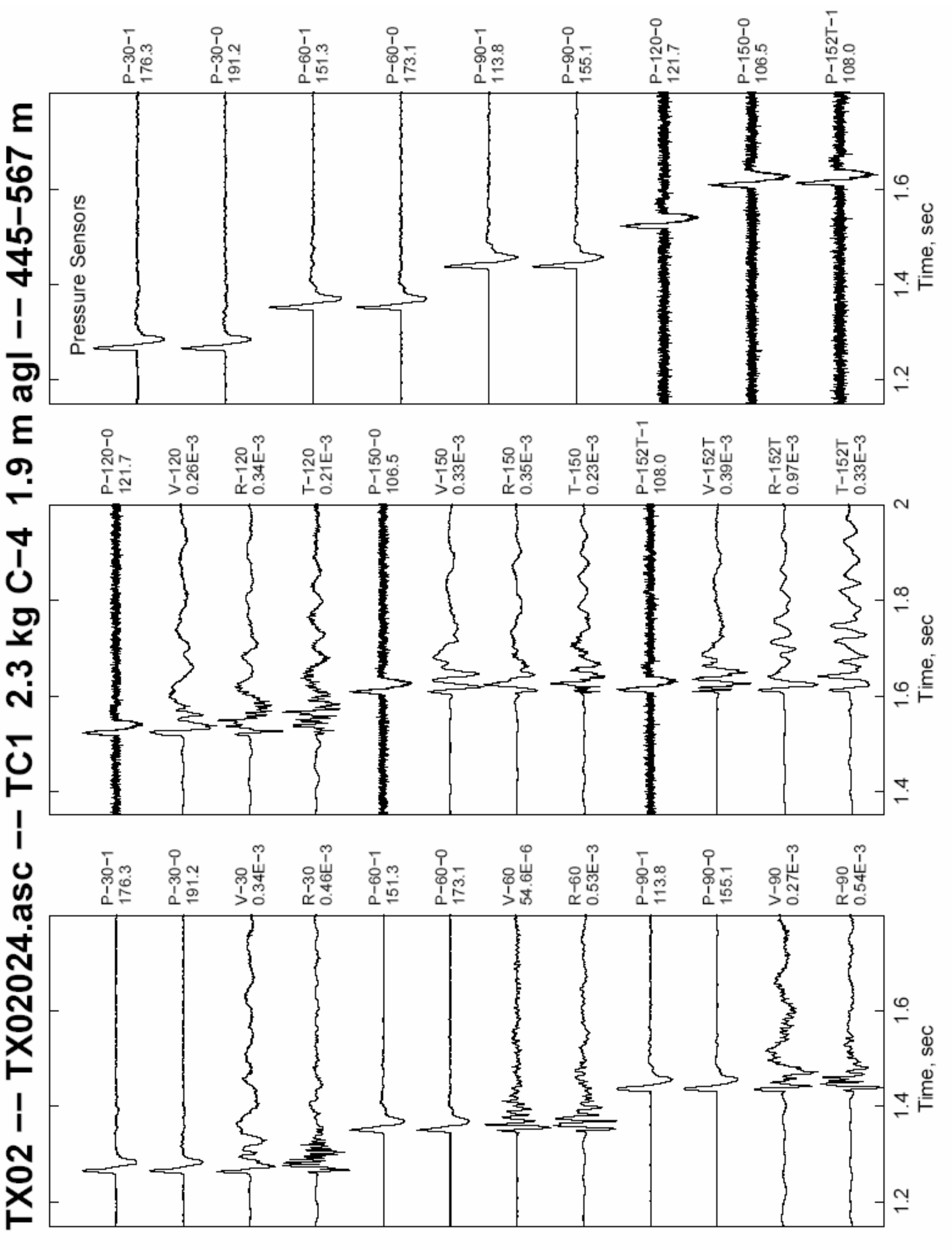

TX02 -- TX02020.asc -- TC1 2.3 kg C-4 1.9 m agl -- 445-567 m
Pressure Sensors
P-30-1 170.7
P-30-0 30.5k
V-30 0.33E-3
R-30 0.42E-3
P-60-1 143.0
P-60-0 160.7
V-60 51.5E-6
R-60 0.45E-3
P-90-1 112.1
P-90-0 148.1
V-90 0.26E-3
R-90 0.47E-3
P-120-0 118.8
V-120 0.28E-3
R-120 0.33E-3
T-120 0.17E-3
P-150-0 113.3
V-150 0.36E-3
R-150 0.34E-3
T-150 0.21E-3
P-152T-1 112.8
V-152T 0.39E-3
R-152T 1.0E-3
T-152T 0.36E-3
Time, sec

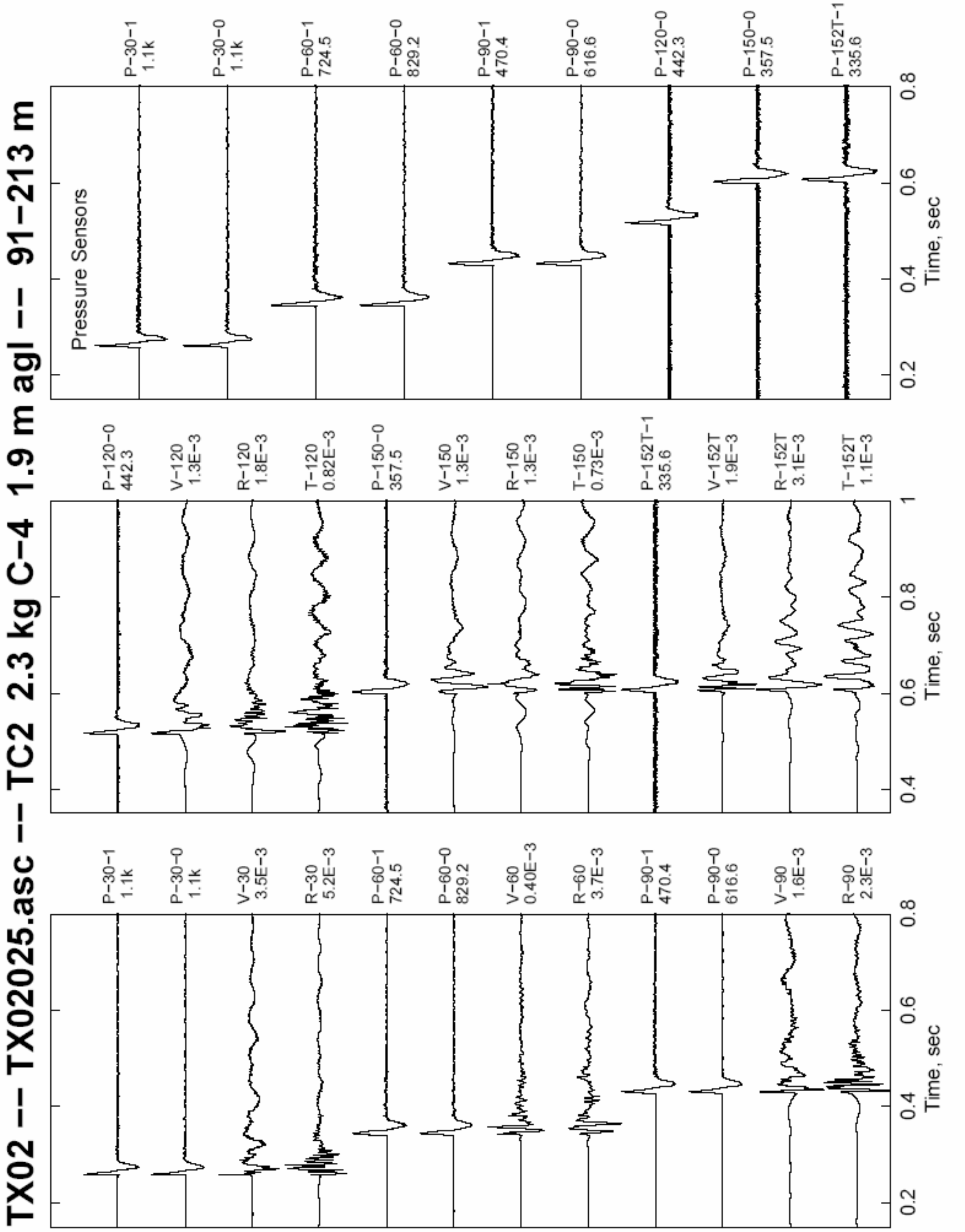

TX02 -- TX02021.asc -- TC2 2.3 kg C-4 1.9 m agl -- 91-213 m
Pressure Sensors
P-30-1 1.1k
P-30-0 1.1k
P-60-1 751.1
P-60-0 884.9
P-90-1 489.4
P-90-0 660.8
P-120-0 465.3
P-150-0 386.2
P-152T-1 360.6
V-120 1.4E-3
R-120 1.9E-3
T-120 0.92E-3
V-150 1.5E-3
R-150 1.4E-3
T-150 0.73E-3
V-152T 2.0E-3
R-152T 3.4E-3
T-152T 1.2E-3
V-30 3.5E-3
R-30 5.4E-3
V-60 0.45E-3
R-60 4.0E-3
V-90 1.8E-3
R-90 2.6E-3
Time, sec

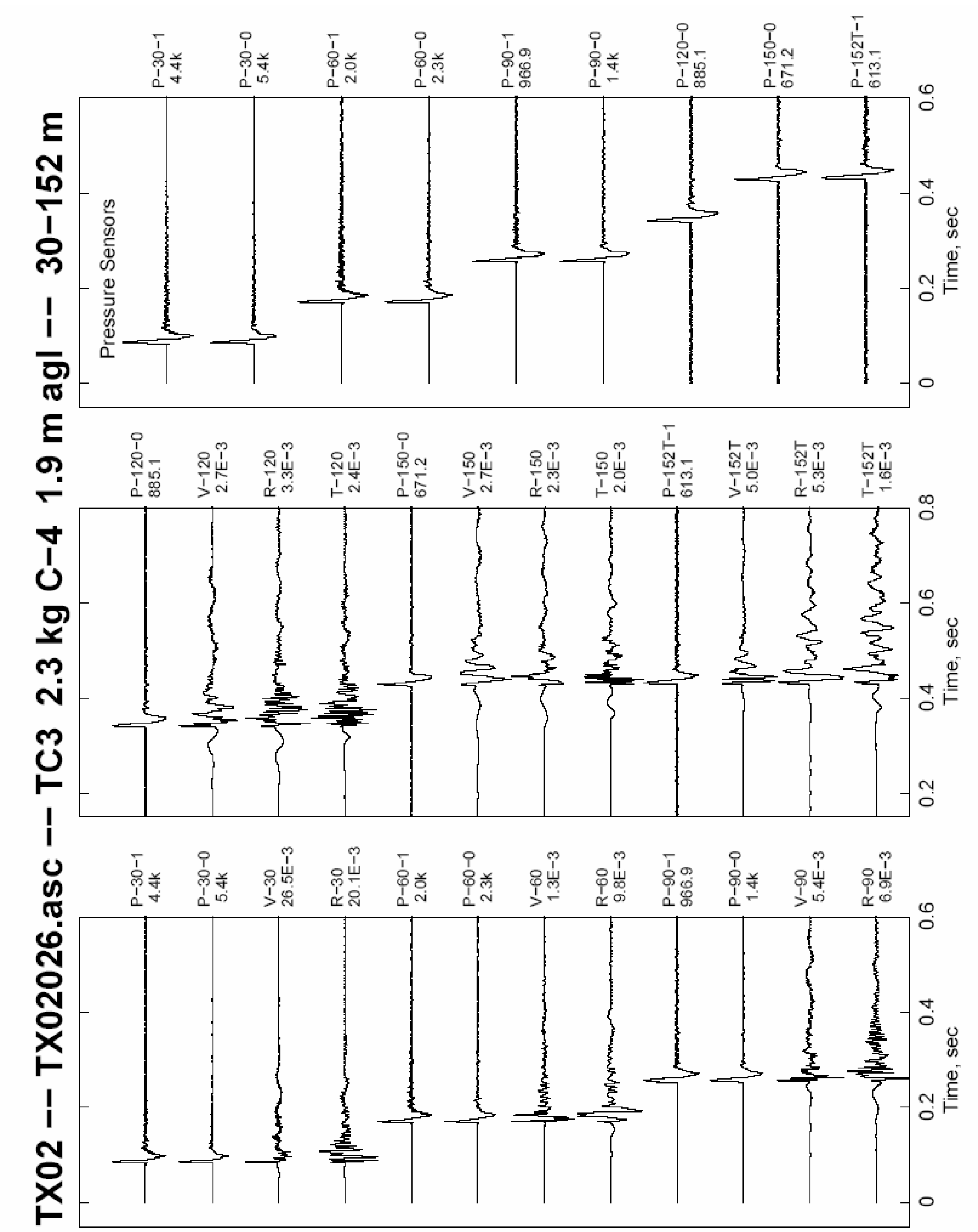

TX02 –– TX02022.asc –– TC3 2.3 kg C–4 1.9 m agl –– 30–152 m
Pressure Sensors
P–30–1 4.7k
P–30–0 5.6k
P–60–1 2.1k
P–60–0 2.5k
P–90–1 1.0k
P–90–0 1.5k
P–120–0 938.8
P–150–0 720.2
P–152T–1 659.5
V–120 2.9E–3
R–120 3.7E–3
T–120 2.5E–3
V–150 2.9E–3
R–150 2.5E–3
T–150 2.2E–3
V–152T 5.4E–3
R–152T 5.7E–3
T–152T 1.7E–3
V–30 28.0E–3
R–30 20.8E–3
V–60 1.4E–3
R–60 10.3E–3
V–90 5.7E–3
R–90 7.2E–3
Time, sec

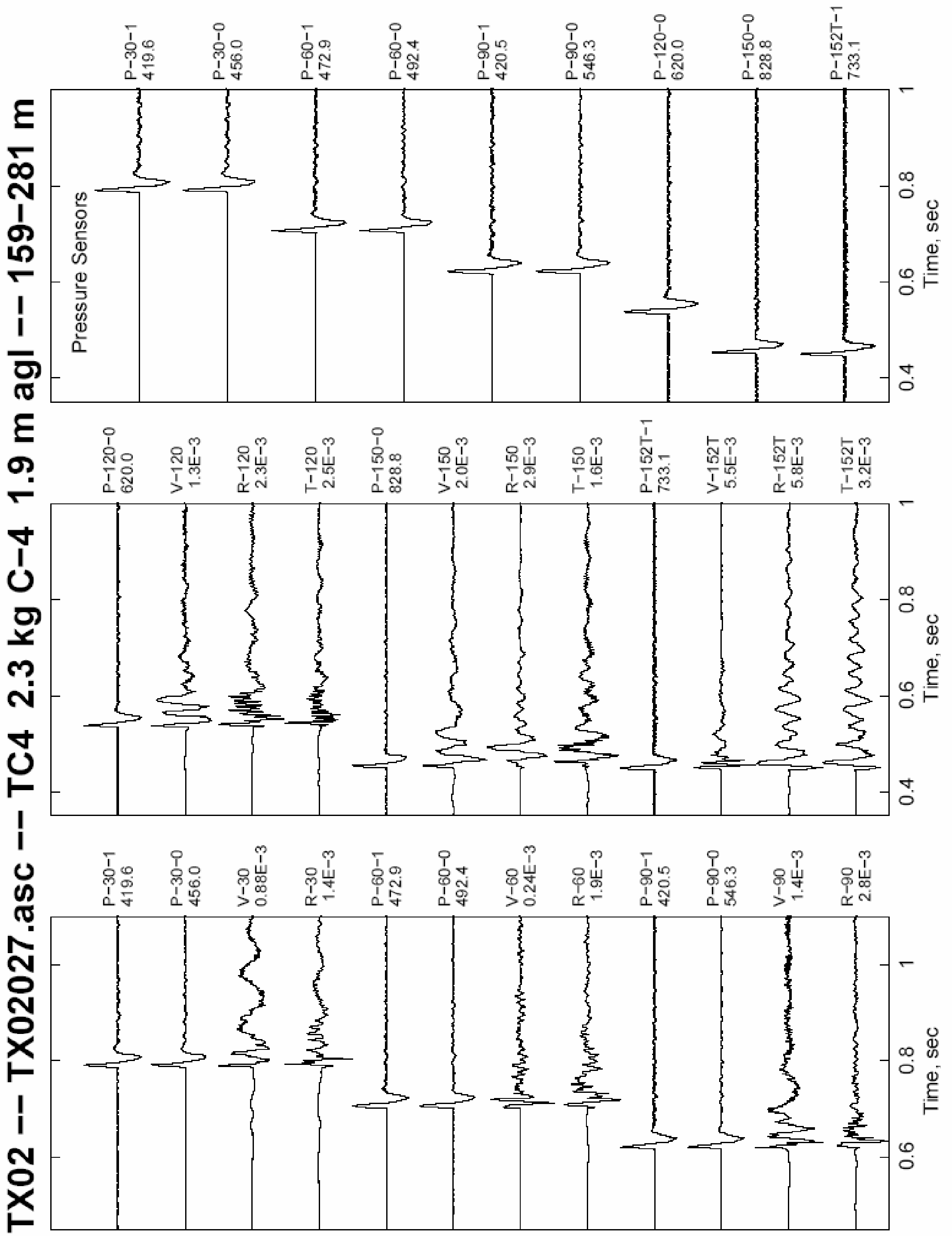


TX02 -- TX02023.asc -- TC4 2.3 kg C-4 1.9 m agl -- 159-281 m
P-30-1 395.5
P-30-0 431.4
V-30 0.82E-3
R-30 1.3E-3
P-60-1 453.5
P-60-0 476.7
V-60 0.23E-3
R-60 1.8E-3
P-90-1 409.0
P-90-0 527.0
V-90 1.4E-3
R-90 2.6E-3
Time, sec
P-120-0 618.1
V-120 1.3E-3
R-120 2.4E-3
T-120 2.5E-3
P-150-0 832.2
V-150 2.0E-3
R-150 2.9E-3
T-150 1.6E-3
P-152T-1 727.7
V-152T 5.5E-3
R-152T 5.7E-3
T-152T 3.2E-3
Time, sec
Pressure Sensors
P-30-1 395.5
P-30-0 431.4
P-60-1 453.5
P-60-0 476.7
P-90-1 409.0
P-90-0 527.0
P-120-0 618.1
P-150-0 832.2
P-152T-1 727.7
Time, sec

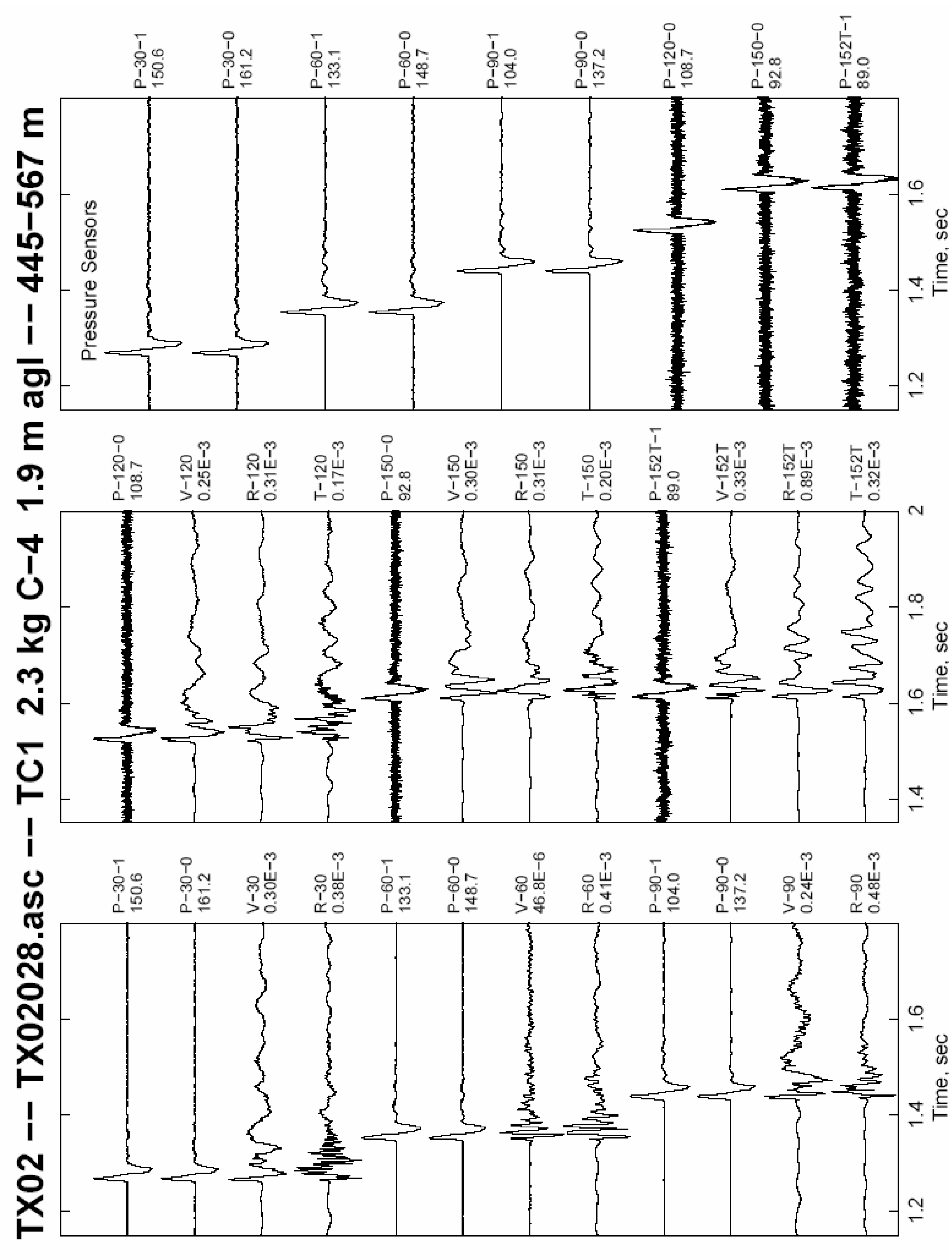

TX02 -- TX02024.asc -- TC1 2.3 kg C-4 1.9 m agl -- 445-567 m
P-30-1 176.3
P-30-0 191.2
V-30 0.34E-3
R-30 0.46E-3
P-60-1 151.3
P-60-0 173.1
V-60 54.6E-6
R-60 0.53E-3
P-90-1 113.8
P-90-0 155.1
V-90 0.27E-3
R-90 0.54E-3
Time, sec
P-120-0 121.7
V-120 0.26E-3
R-120 0.34E-3
T-120 0.21E-3
P-150-0 106.5
V-150 0.33E-3
R-150 0.35E-3
T-150 0.23E-3
P-152T-1 108.0
V-152T 0.39E-3
R-152T 0.97E-3
T-152T 0.33E-3
Time, sec
Pressure Sensors
P-30-1 176.3
P-30-0 191.2
P-60-1 151.3
P-60-0 173.1
P-90-1 113.8
P-90-0 155.1
P-120-0 121.7
P-150-0 106.5
P-152T-1 108.0
Time, sec


TX02 -- TX02025.asc -- TC2 2.3 kg C-4 1.9 m agl -- 91-213 m
Pressure Sensors
Time, sec
P-30-1 1.1k
P-30-0 1.1k
V-30 3.5E-3
R-30 5.2E-3
P-60-1 724.5
P-60-0 829.2
V-60 0.40E-3
R-60 3.7E-3
P-90-1 470.4
P-90-0 616.6
V-90 1.6E-3
R-90 2.3E-3
P-120-0 442.3
V-120 1.3E-3
R-120 1.8E-3
T-120 0.82E-3
P-150-0 357.5
V-150 1.3E-3
R-150 1.3E-3
T-150 0.73E-3
P-152T-1 335.6
V-152T 1.9E-3
R-152T 3.1E-3
T-152T 1.1E-3

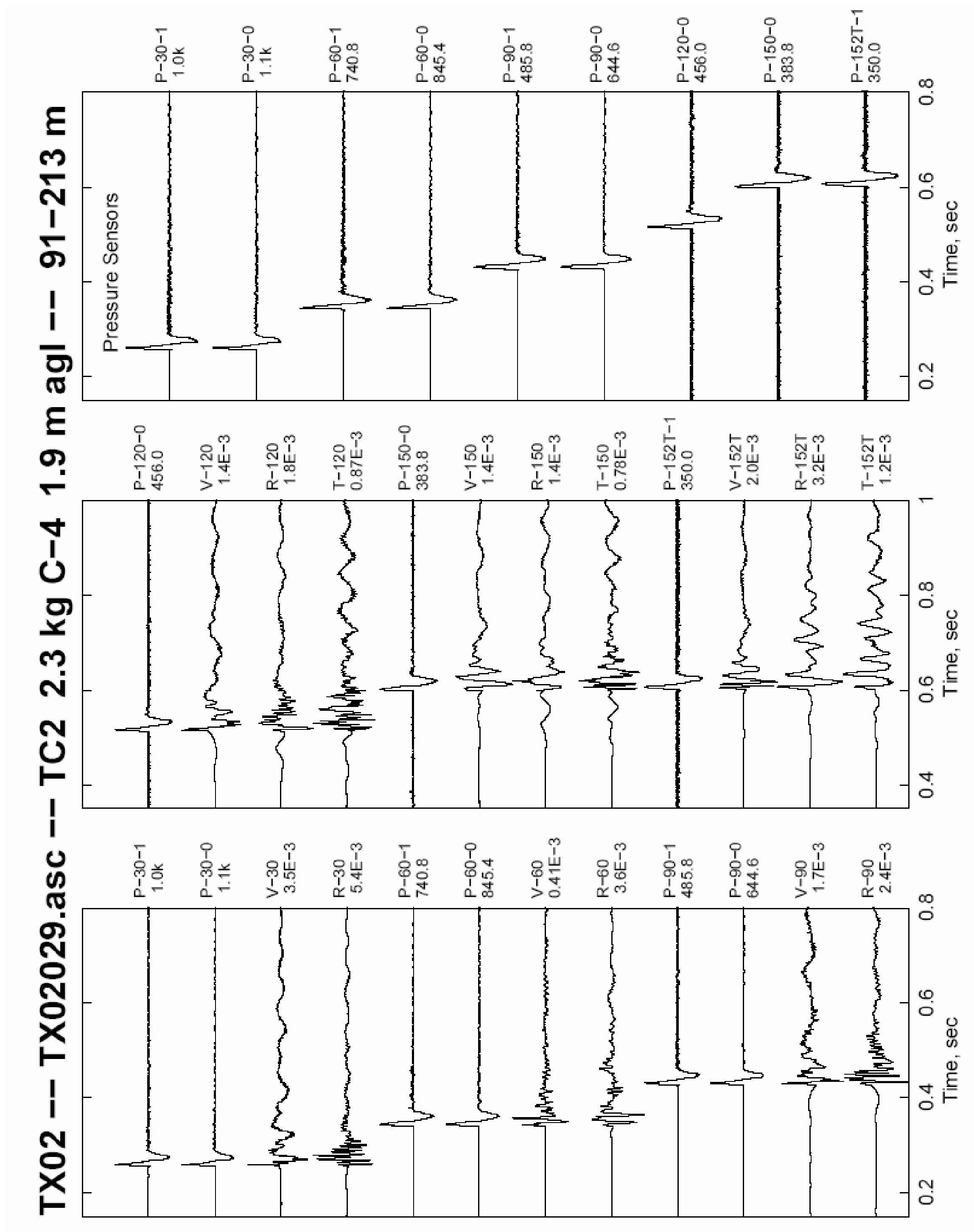

TX02 -- TX02026.asc -- TC3 2.3 kg C-4 1.9 m agl -- 30–152 m
Pressure Sensors
Time, sec
P–30–1 4.4k
P–30–0 5.4k
P–60–1 2.0k
P–60–0 2.3k
P–90–1 966.9
P–90–0 1.4k
P–120–0 885.1
P–150–0 671.2
P–152T–1 613.1
V–120 2.7E–3
R–120 3.3E–3
T–120 2.4E–3
V–150 2.7E–3
R–150 2.3E–3
T–150 2.0E–3
V–152T 5.0E–3
R–152T 5.3E–3
T–152T 1.6E–3
V–30 26.5E–3
R–30 20.1E–3
V–60 1.3E–3
R–60 9.8E–3
V–90 5.4E–3
R–90 6.9E–3

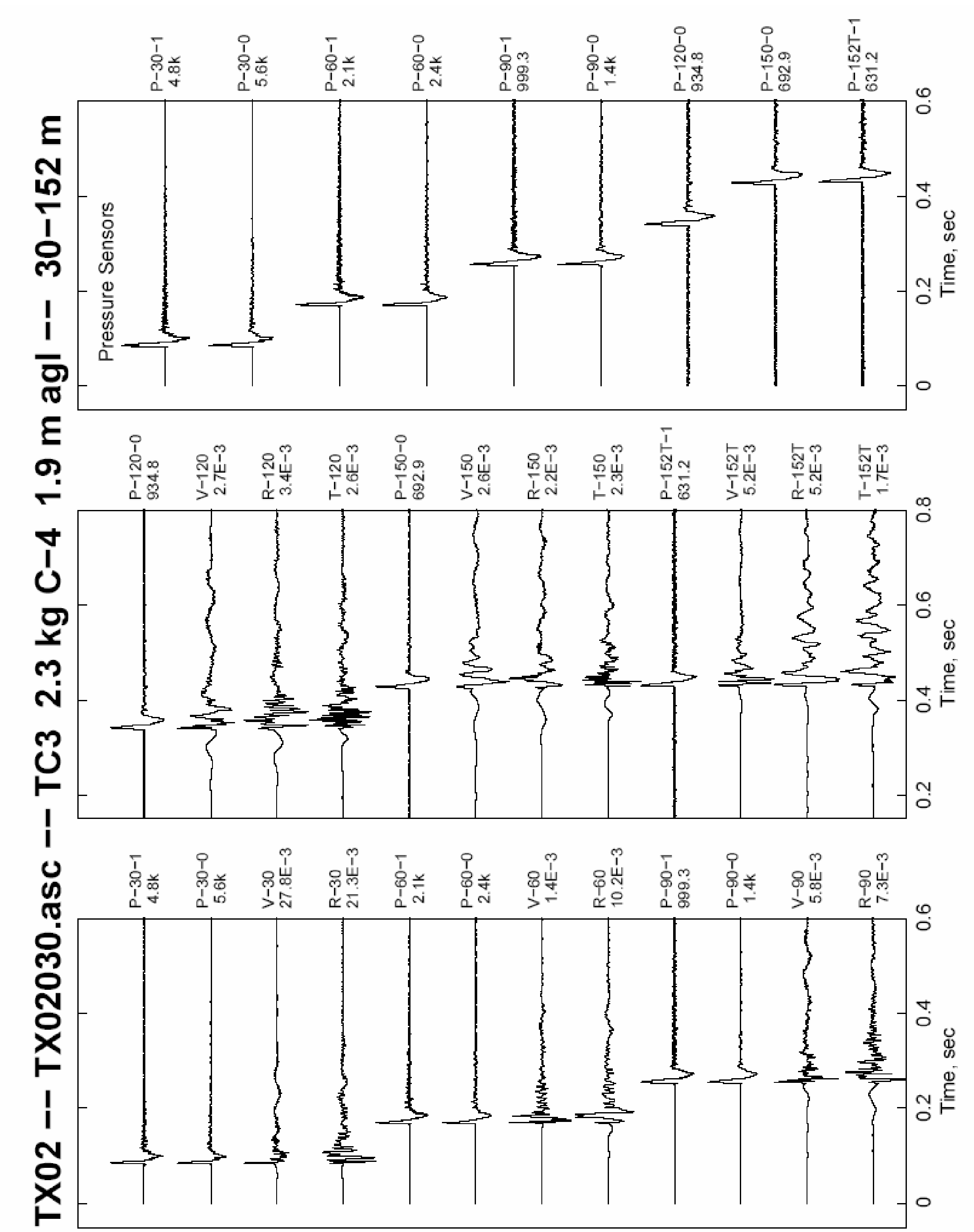


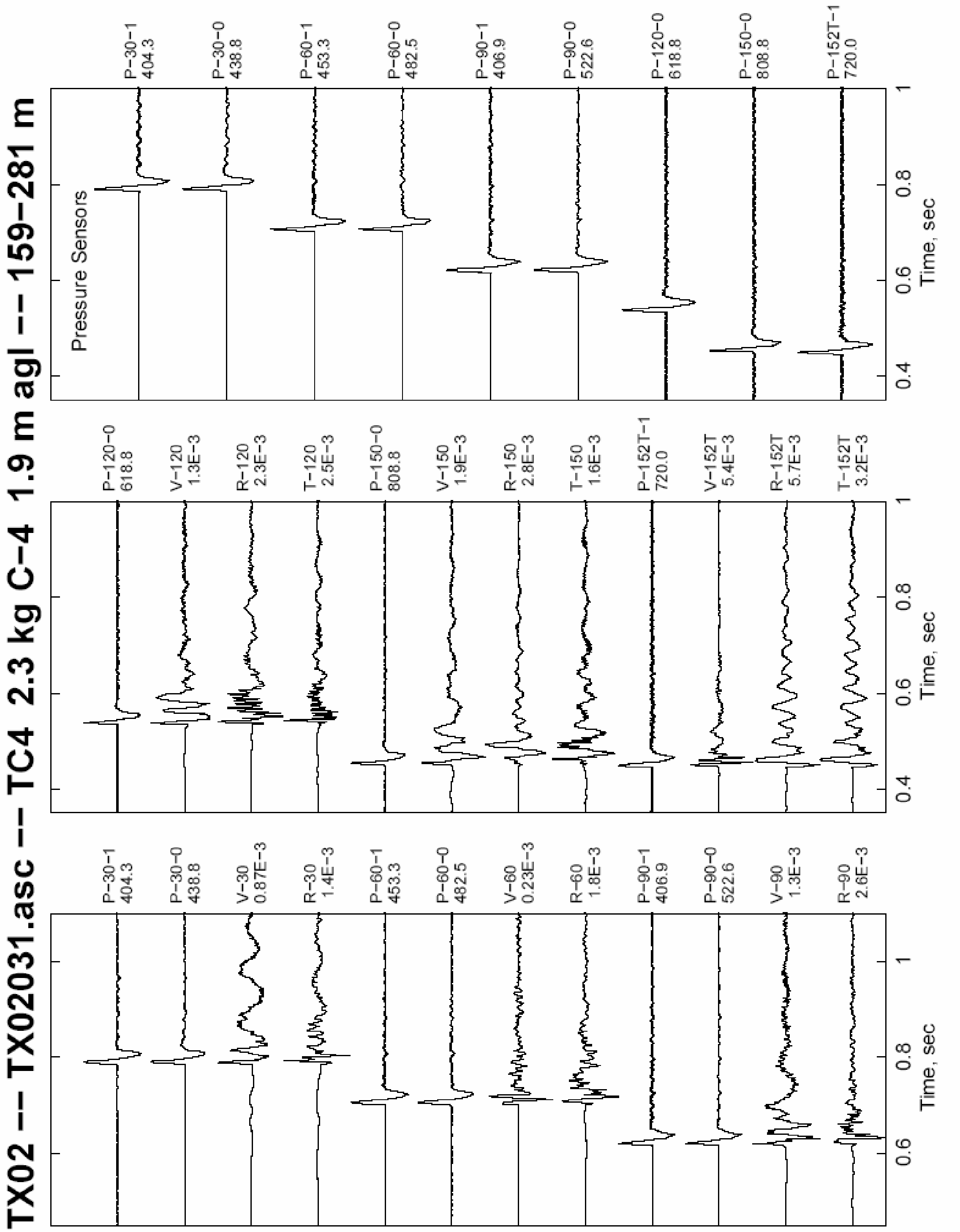
TX02 -- TX02027.asc -- TC4 2.3 kg C-4 1.9 m agl -- 159-281 m
P-30-1 419.6
P-30-0 456.0
V-30 0.88E-3
R-30 1.4E-3
P-60-1 472.9
P-60-0 492.4
V-60 0.24E-3
R-60 1.9E-3
P-90-1 420.5
P-90-0 546.3
V-90 1.4E-3
R-90 2.8E-3
Time, sec
P-120-0 620.0
V-120 1.3E-3
R-120 2.3E-3
T-120 2.5E-3
P-150-0 828.8
V-150 2.0E-3
R-150 2.9E-3
T-150 1.6E-3
P-152T-1 733.1
V-152T 5.5E-3
R-152T 5.8E-3
T-152T 3.2E-3
Time, sec
Pressure Sensors
P-30-1 419.6
P-30-0 456.0
P-60-1 472.9
P-60-0 492.4
P-90-1 420.5
P-90-0 546.3
P-120-0 620.0
P-150-0 828.8
P-152T-1 733.1
Time, sec

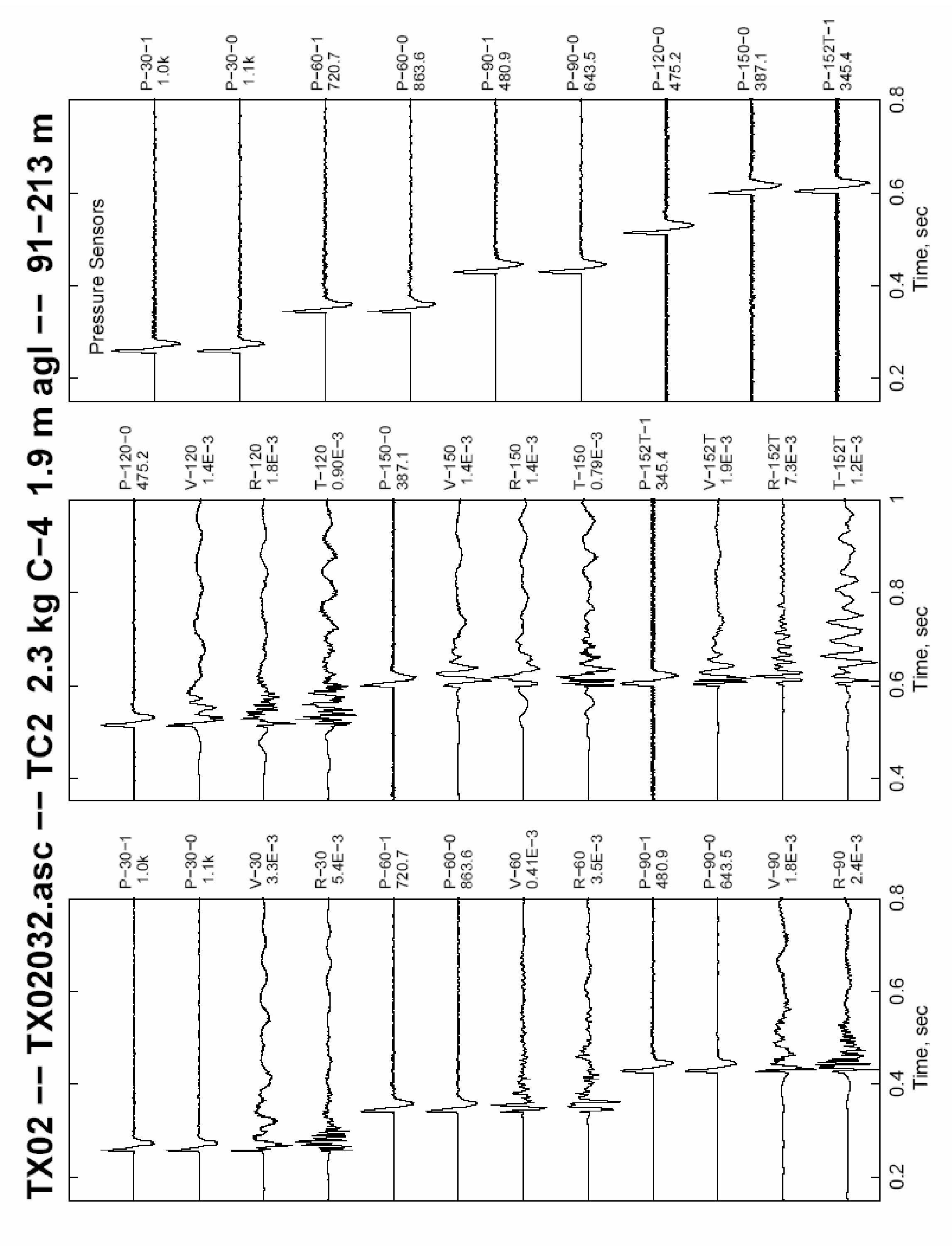


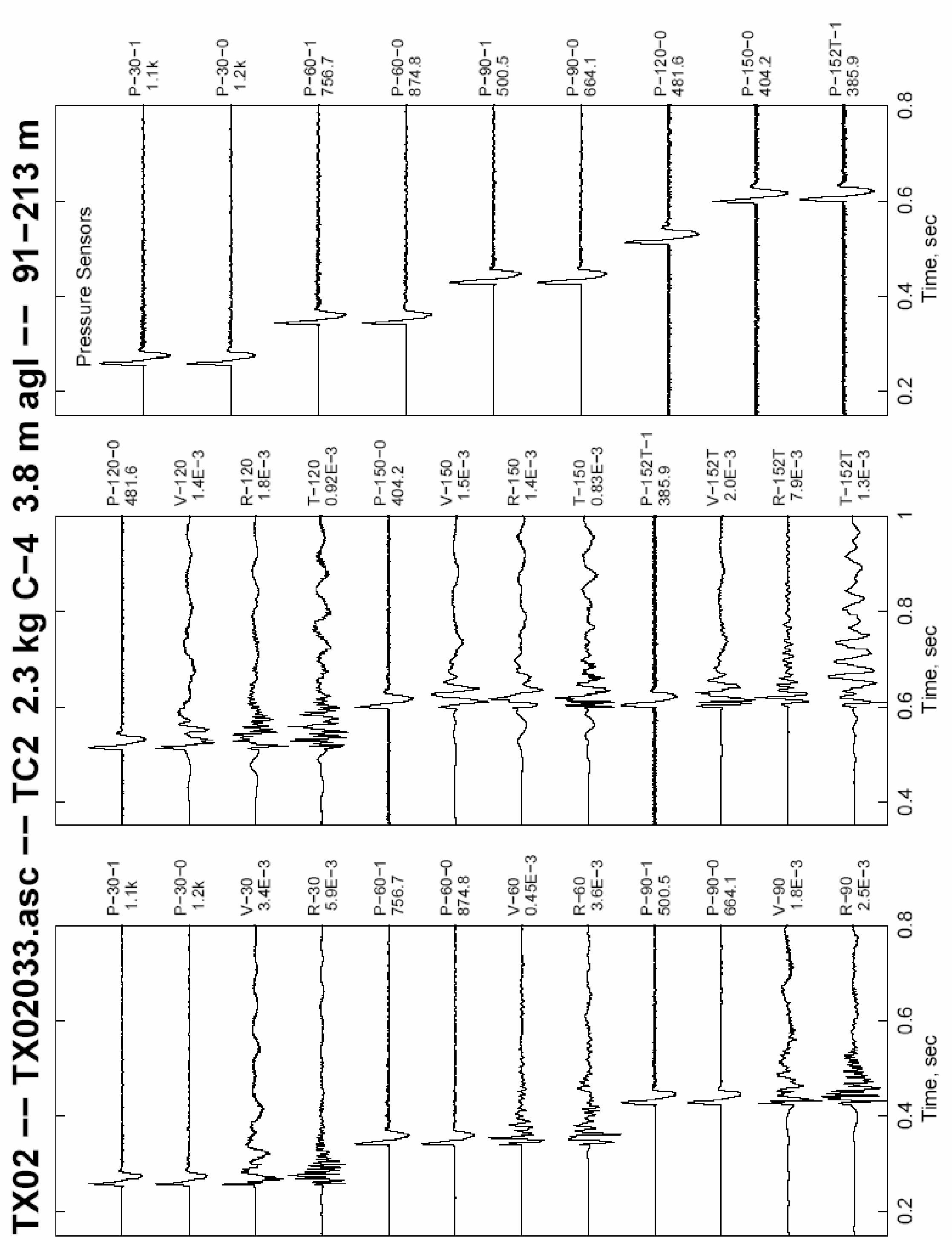
TX02 -- TX02028.asc -- TC1 2.3 kg C-4 1.9 m agl -- 445-567 m
Pressure Sensors
P-30-1 150.6
P-30-0 161.2
P-60-1 133.1
P-60-0 148.7
P-90-1 104.0
P-90-0 137.2
P-120-0 108.7
P-150-0 92.8
P-152T-1 89.0
Time, sec
1.2
1.4
1.6
P-120-0 108.7
V-120 0.25E-3
R-120 0.31E-3
T-120 0.17E-3
P-150-0 92.8
V-150 0.30E-3
R-150 0.31E-3
T-150 0.20E-3
P-152T-1 89.0
V-152T 0.33E-3
R-152T 0.89E-3
T-152T 0.32E-3
Time, sec
1.4
1.6
1.8
2
P-30-1 150.6
P-30-0 161.2
V-30 0.30E-3
R-30 0.38E-3
P-60-1 133.1
P-60-0 148.7
V-60 46.8E-6
R-60 0.41E-3
P-90-1 104.0
P-90-0 137.2
V-90 0.24E-3
R-90 0.48E-3
Time, sec
1.2
1.4
1.6

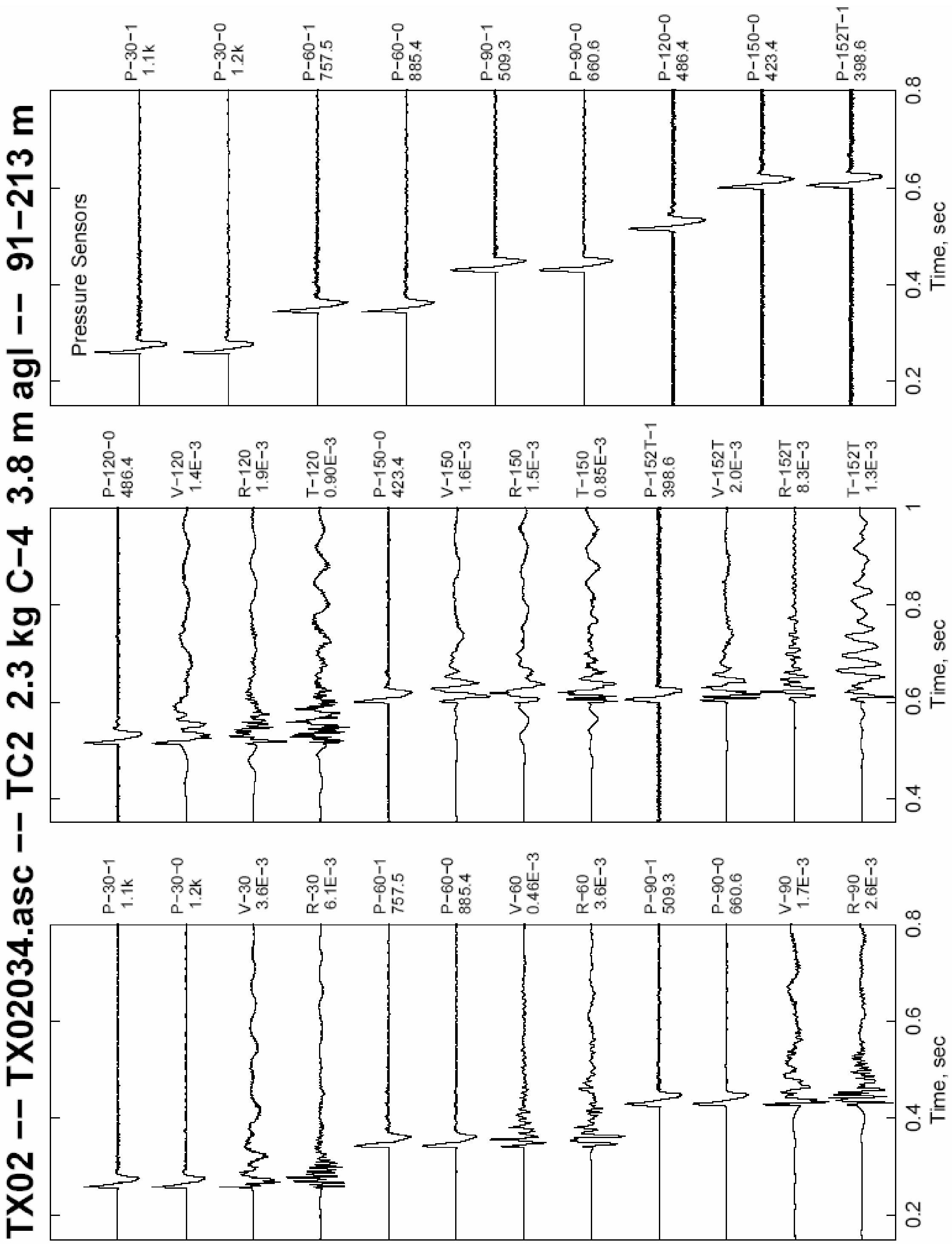

TX02 -- TX02029.asc -- TC2 2.3 kg C-4 1.9 m agl -- 91-213 m
P-30-1 1.0k
P-30-0 1.1k
V-30 3.5E-3
R-30 5.4E-3
P-60-1 740.8
P-60-0 845.4
V-60 0.41E-3
R-60 3.6E-3
P-90-1 485.8
P-90-0 644.6
V-90 1.7E-3
R-90 2.4E-3
Time, sec
P-120-0 456.0
V-120 1.4E-3
R-120 1.8E-3
T-120 0.87E-3
P-150-0 383.8
V-150 1.4E-3
R-150 1.4E-3
T-150 0.78E-3
P-152T-1 350.0
V-152T 2.0E-3
R-152T 3.2E-3
T-152T 1.2E-3
Time, sec
Pressure Sensors
P-30-1 1.0k
P-30-0 1.1k
P-60-1 740.8
P-60-0 845.4
P-90-1 485.8
P-90-0 644.6
P-120-0 456.0
P-150-0 383.8
P-152T-1 350.0
Time, sec

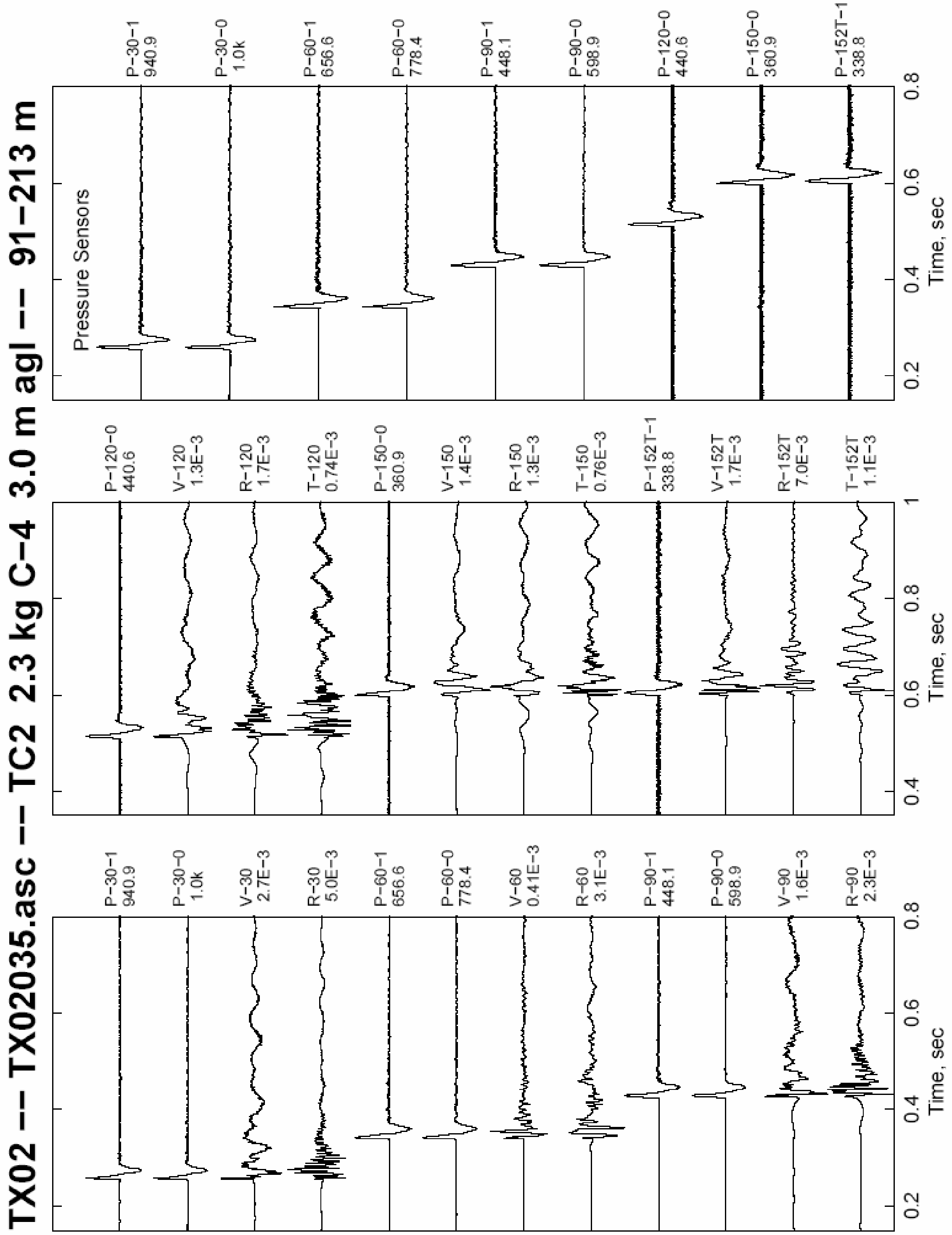

TX02 -- TX02030.asc -- TC3 2.3 kg C-4 1.9 m agl -- 30-152 m
P-30-1 4.8k
P-30-0 5.6k
V-30 27.8E-3
R-30 21.3E-3
P-60-1 2.1k
P-60-0 2.4k
V-60 1.4E-3
R-60 10.2E-3
P-90-1 999.3
P-90-0 1.4k
V-90 5.8E-3
R-90 7.3E-3
Time, sec
P-120-0 934.8
V-120 2.7E-3
R-120 3.4E-3
T-120 2.6E-3
P-150-0 692.9
V-150 2.6E-3
R-150 2.2E-3
T-150 2.3E-3
P-152T-1 631.2
V-152T 5.2E-3
R-152T 5.2E-3
T-152T 1.7E-3
Time, sec
Pressure Sensors
P-30-1 4.8k
P-30-0 5.6k
P-60-1 2.1k
P-60-0 2.4k
P-90-1 999.3
P-90-0 1.4k
P-120-0 934.8
P-150-0 692.9
P-152T-1 631.2
Time, sec


TX02 -- TX02031.asc -- TC4 2.3 kg C-4 1.9 m agl -- 159-281 m
Pressure Sensors
P-30-1 404.3
P-30-0 438.8
V-30 0.87E-3
R-30 1.4E-3
P-60-1 453.3
P-60-0 482.5
V-60 0.23E-3
R-60 1.8E-3
P-90-1 406.9
P-90-0 522.6
V-90 1.3E-3
R-90 2.6E-3
P-120-0 618.8
V-120 1.3E-3
R-120 2.3E-3
T-120 2.5E-3
P-150-0 808.8
V-150 1.9E-3
R-150 2.8E-3
T-150 1.6E-3
P-152T-1 720.0
V-152T 5.4E-3
R-152T 5.7E-3
T-152T 3.2E-3
Time, sec

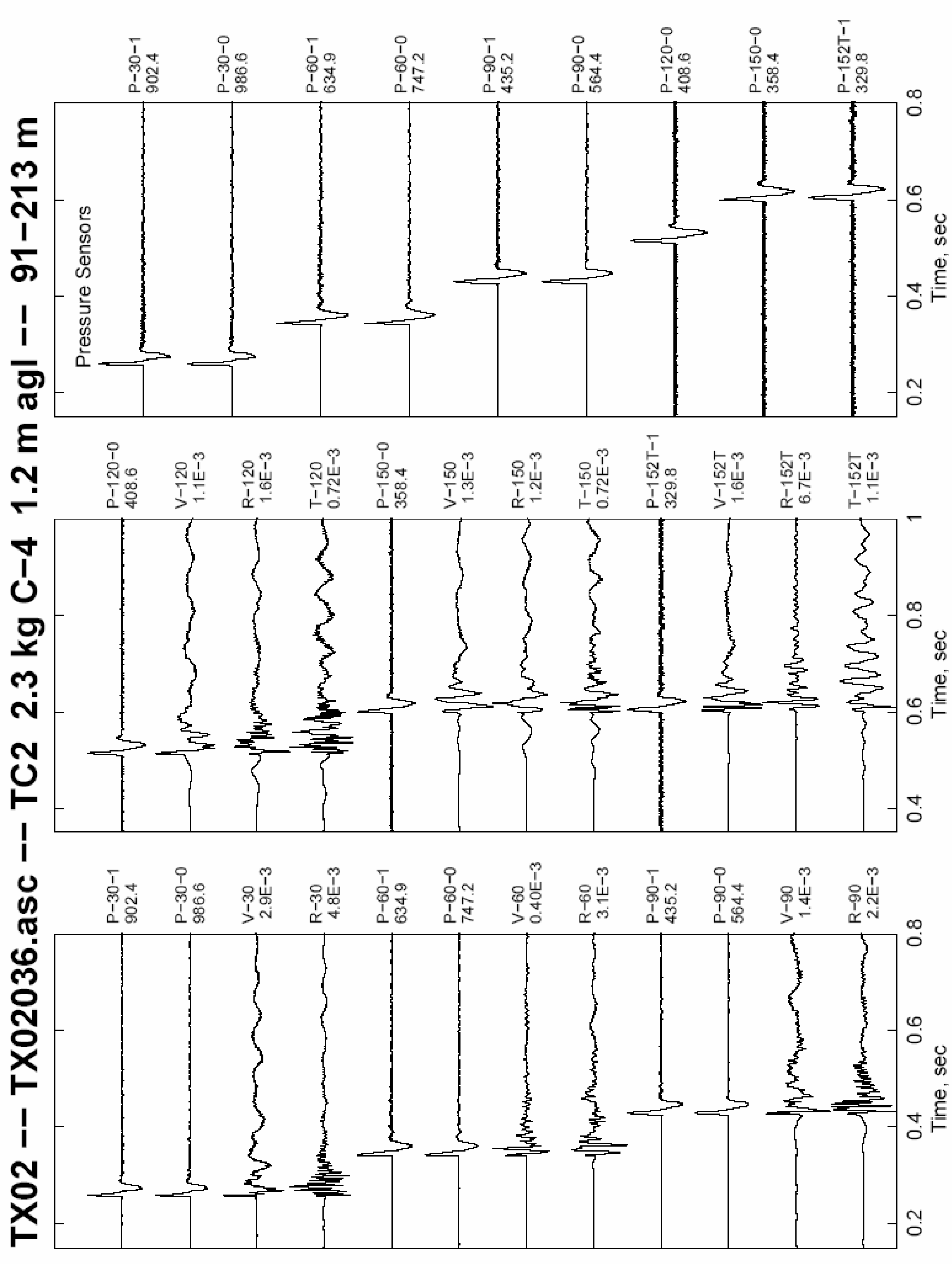

TX02 -- TX02032.asc -- TC2 2.3 kg C-4 1.9 m agl -- 91-213 m
Pressure Sensors
P-30-1 1.0k
P-30-0 1.1k
V-30 3.3E-3
R-30 5.4E-3
P-60-1 720.7
P-60-0 863.6
V-60 0.41E-3
R-60 3.5E-3
P-90-1 480.9
P-90-0 643.5
V-90 1.8E-3
R-90 2.4E-3
P-120-0 475.2
V-120 1.4E-3
R-120 1.8E-3
T-120 0.90E-3
P-150-0 387.1
V-150 1.4E-3
R-150 1.4E-3
T-150 0.79E-3
P-152T-1 345.4
V-152T 1.9E-3
R-152T 7.3E-3
T-152T 1.2E-3
Time, sec

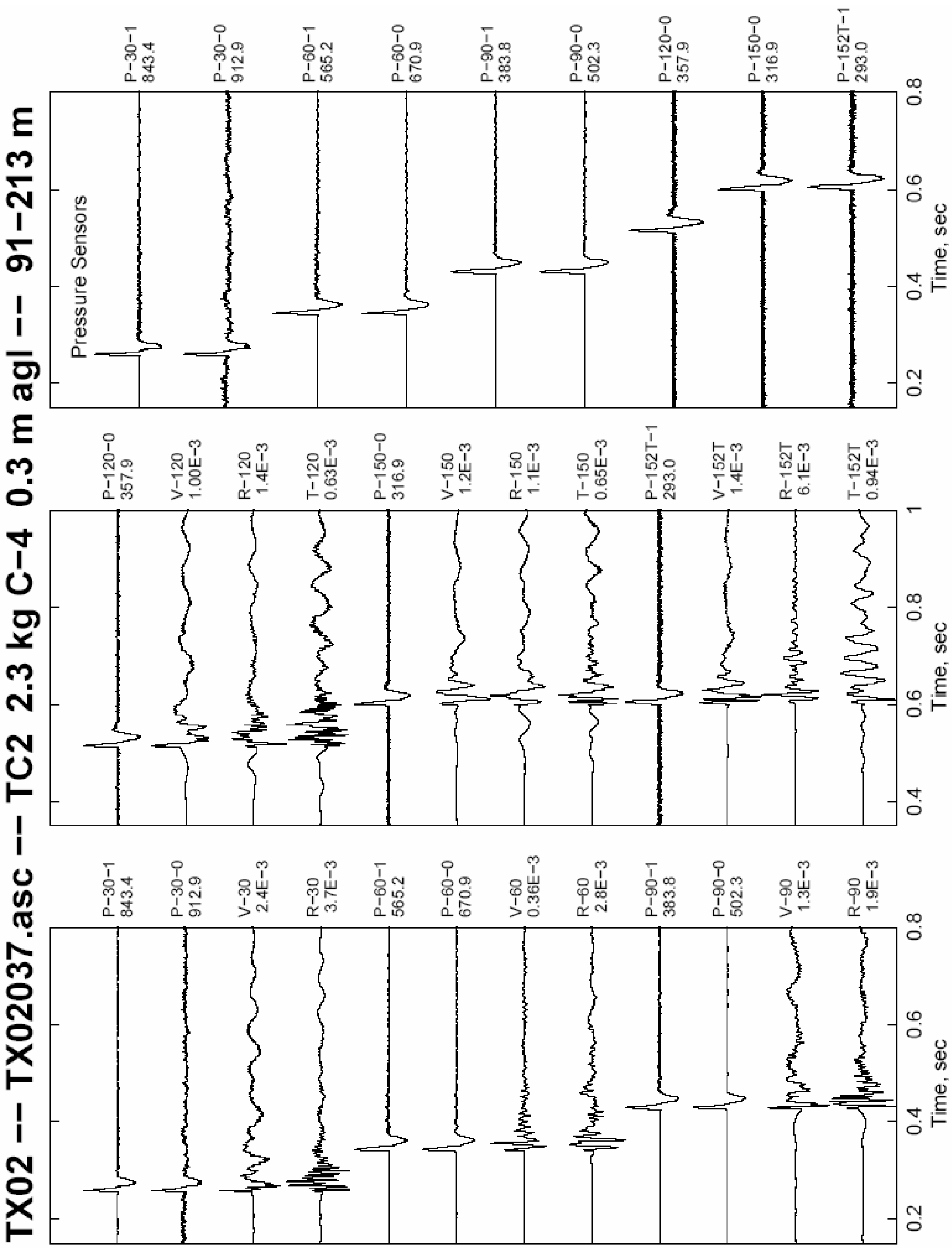

TX02 -- TX02033.asc -- TC2 2.3 kg C-4 3.8 m agl -- 91-213 m
Pressure Sensors
Time, sec
Time, sec
Time, sec

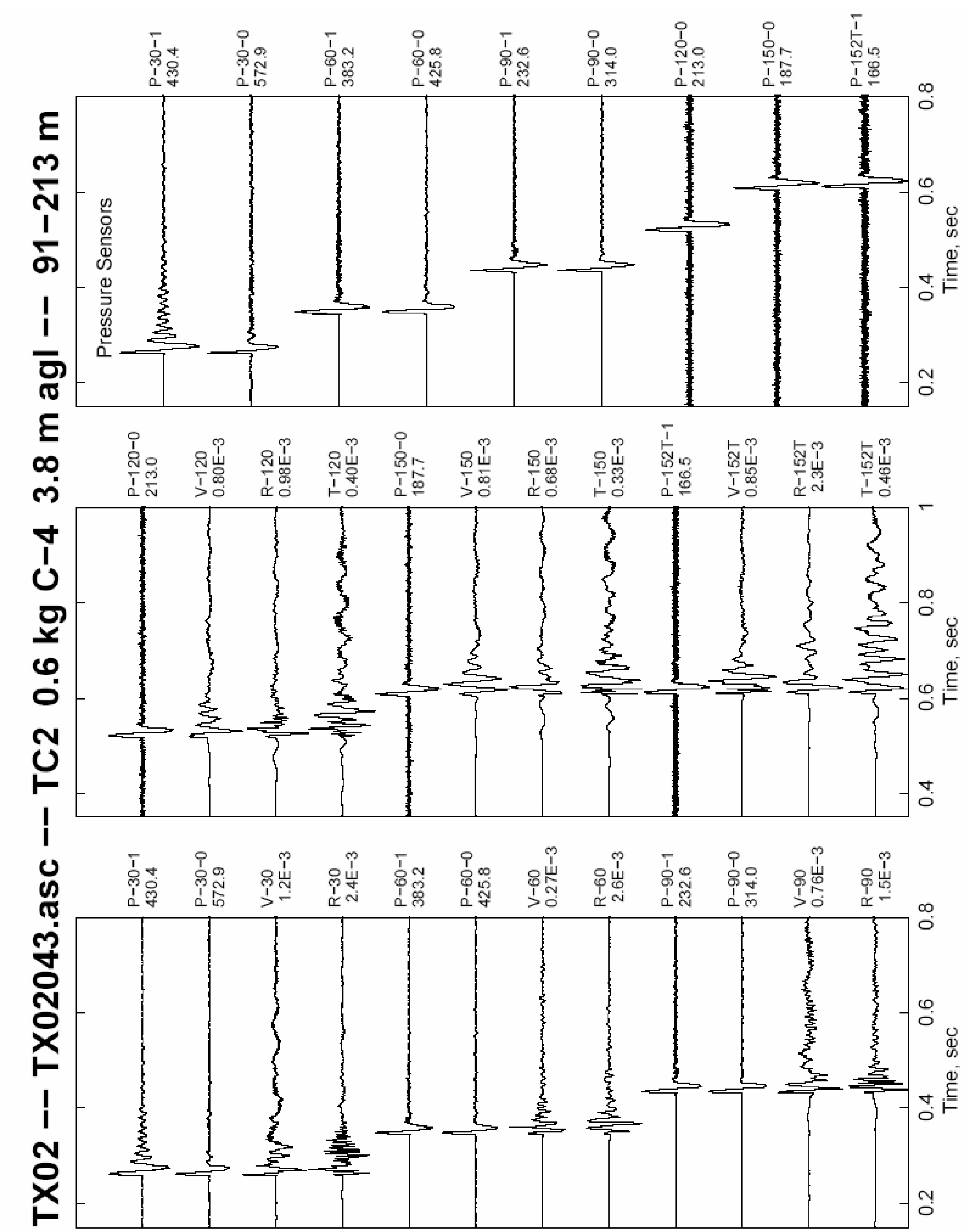

TX02 -- TX02034.asc -- TC2 2.3 kg C–4 3.8 m agl -- 91–213 m
Pressure Sensors
P–30–1 1.1k
P–30–0 1.2k
P–60–1 757.5
P–60–0 885.4
P–90–1 509.3
P–90–0 660.6
P–120–0 486.4
P–150–0 423.4
P–152T–1 398.6
Time, sec
P–120–0 486.4
V–120 1.4E–3
R–120 1.9E–3
T–120 0.90E–3
P–150–0 423.4
V–150 1.6E–3
R–150 1.5E–3
T–150 0.85E–3
P–152T–1 398.6
V–152T 2.0E–3
R–152T 8.3E–3
T–152T 1.3E–3
Time, sec
P–30–1 1.1k
P–30–0 1.2k
V–30 3.6E–3
R–30 6.1E–3
P–60–1 757.5
P–60–0 885.4
V–60 0.46E–3
R–60 3.6E–3
P–90–1 509.3
P–90–0 660.6
V–90 1.7E–3
R–90 2.6E–3
Time, sec

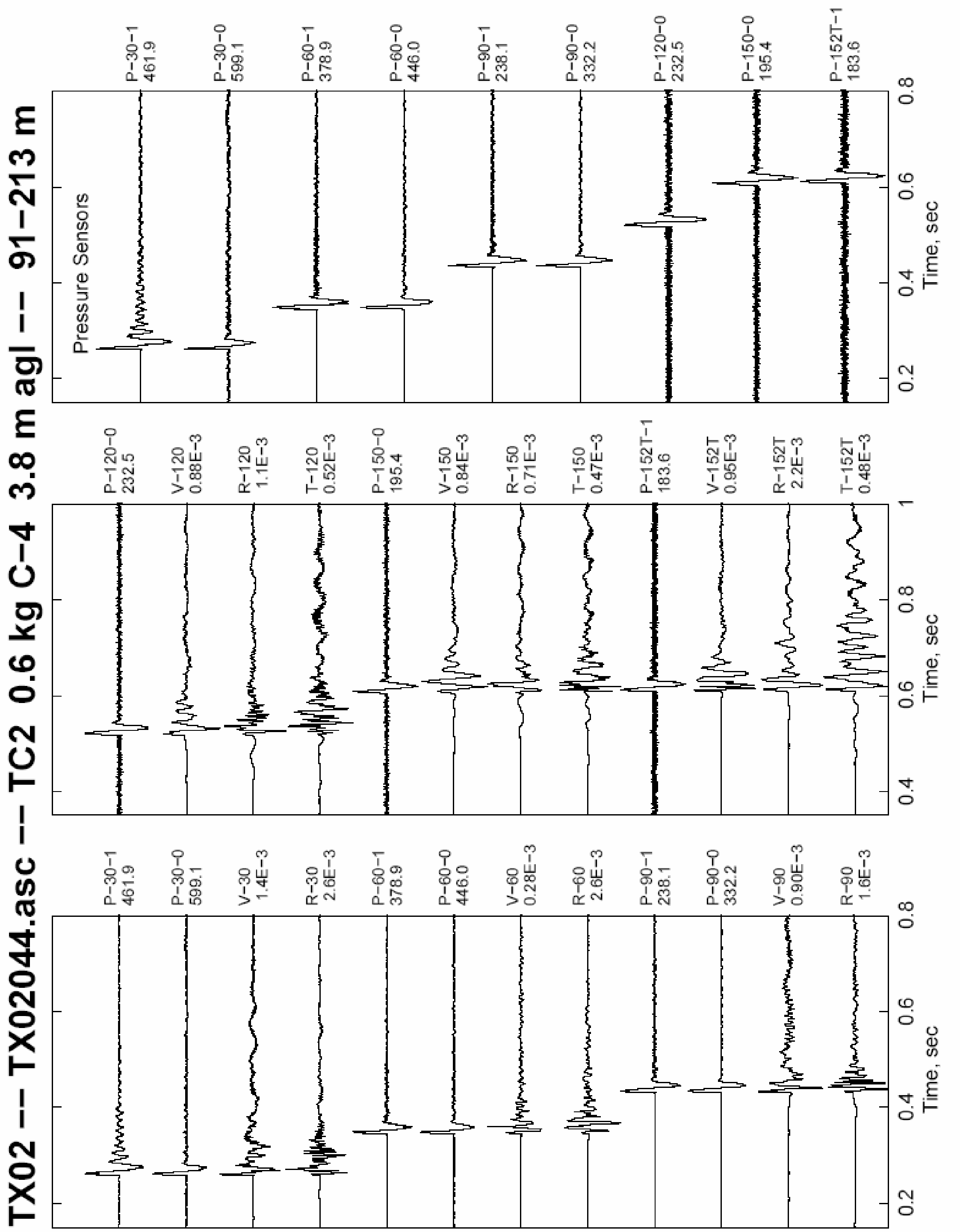


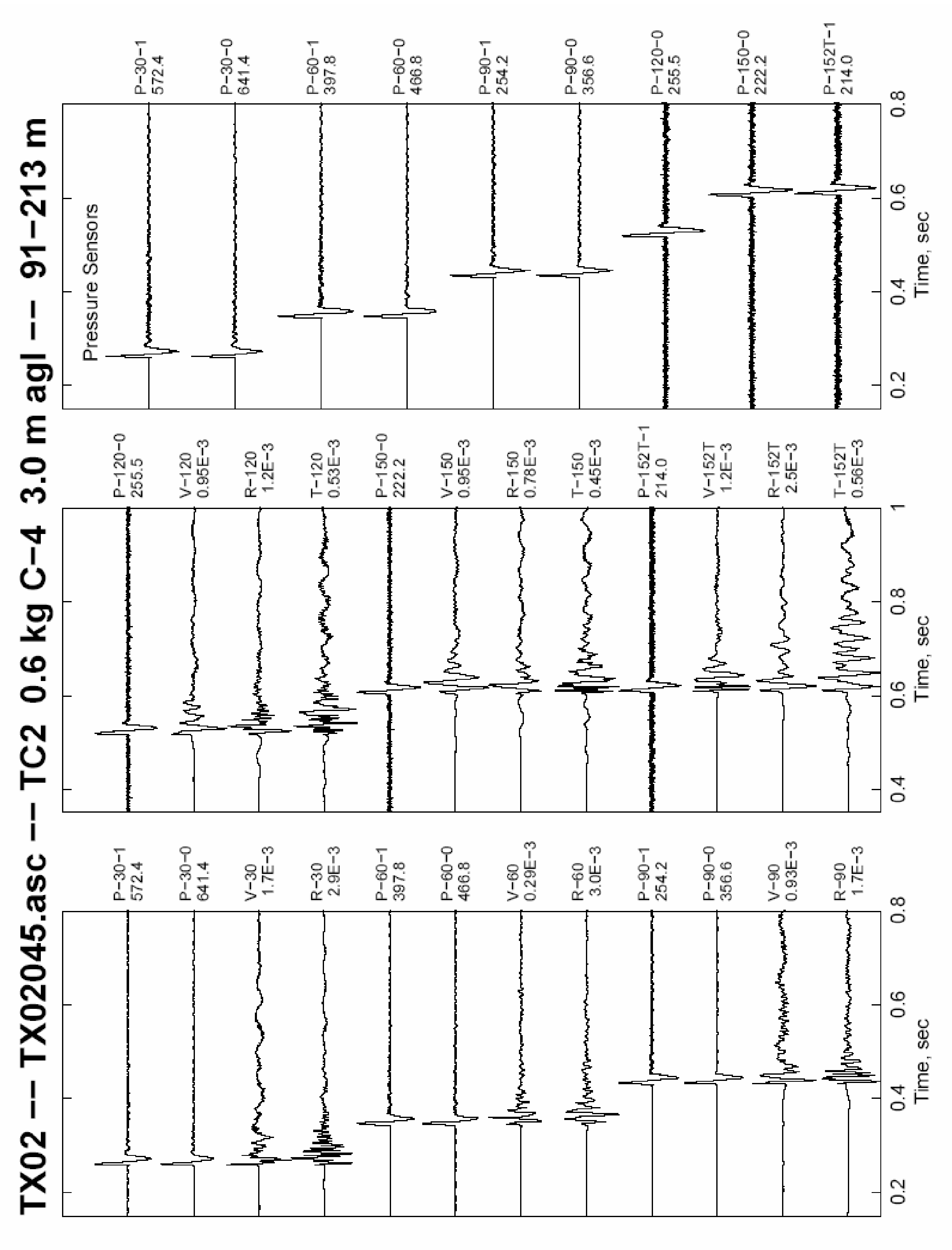
TX02 -- TX02035.asc -- TC2 2.3 kg C-4 3.0 m agl -- 91-213 m
Pressure Sensors
Time, sec
P-30-1 940.9
P-30-0 1.0k
V-30 2.7E-3
R-30 5.0E-3
P-60-1 656.6
P-60-0 778.4
V-60 0.41E-3
R-60 3.1E-3
P-90-1 448.1
P-90-0 598.9
V-90 1.6E-3
R-90 2.3E-3
P-120-0 440.6
V-120 1.3E-3
R-120 1.7E-3
T-120 0.74E-3
P-150-0 360.9
V-150 1.4E-3
R-150 1.3E-3
T-150 0.76E-3
P-152T-1 338.8
V-152T 1.7E-3
R-152T 7.0E-3
T-152T 1.1E-3

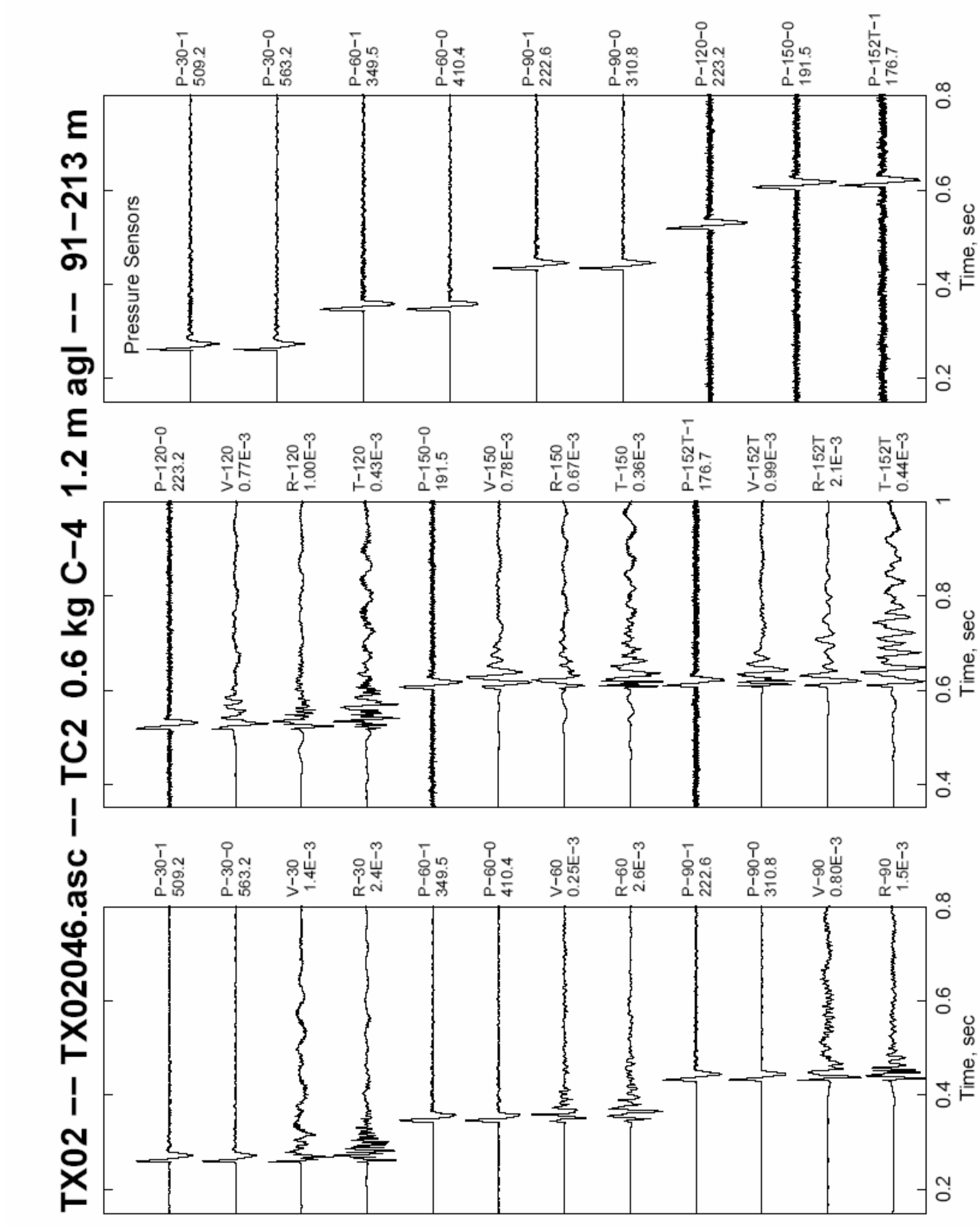

TX02 -- TX02036.asc -- TC2 2.3 kg C-4 1.2 m agl -- 91–213 m
P–30–1 902.4
P–30–0 986.6
V–30 2.9E–3
R–30 4.8E–3
P–60–1 634.9
P–60–0 747.2
V–60 0.40E–3
R–60 3.1E–3
P–90–1 435.2
P–90–0 564.4
V–90 1.4E–3
R–90 2.2E–3
Time, sec
P–120–0 408.6
V–120 1.1E–3
R–120 1.6E–3
T–120 0.72E–3
P–150–0 358.4
V–150 1.3E–3
R–150 1.2E–3
T–150 0.72E–3
P–152T–1 329.8
V–152T 1.6E–3
R–152T 6.7E–3
T–152T 1.1E–3
Time, sec
Pressure Sensors
P–30–1 902.4
P–30–0 986.6
P–60–1 634.9
P–60–0 747.2
P–90–1 435.2
P–90–0 564.4
P–120–0 408.6
P–150–0 358.4
P–152T–1 329.8
Time, sec

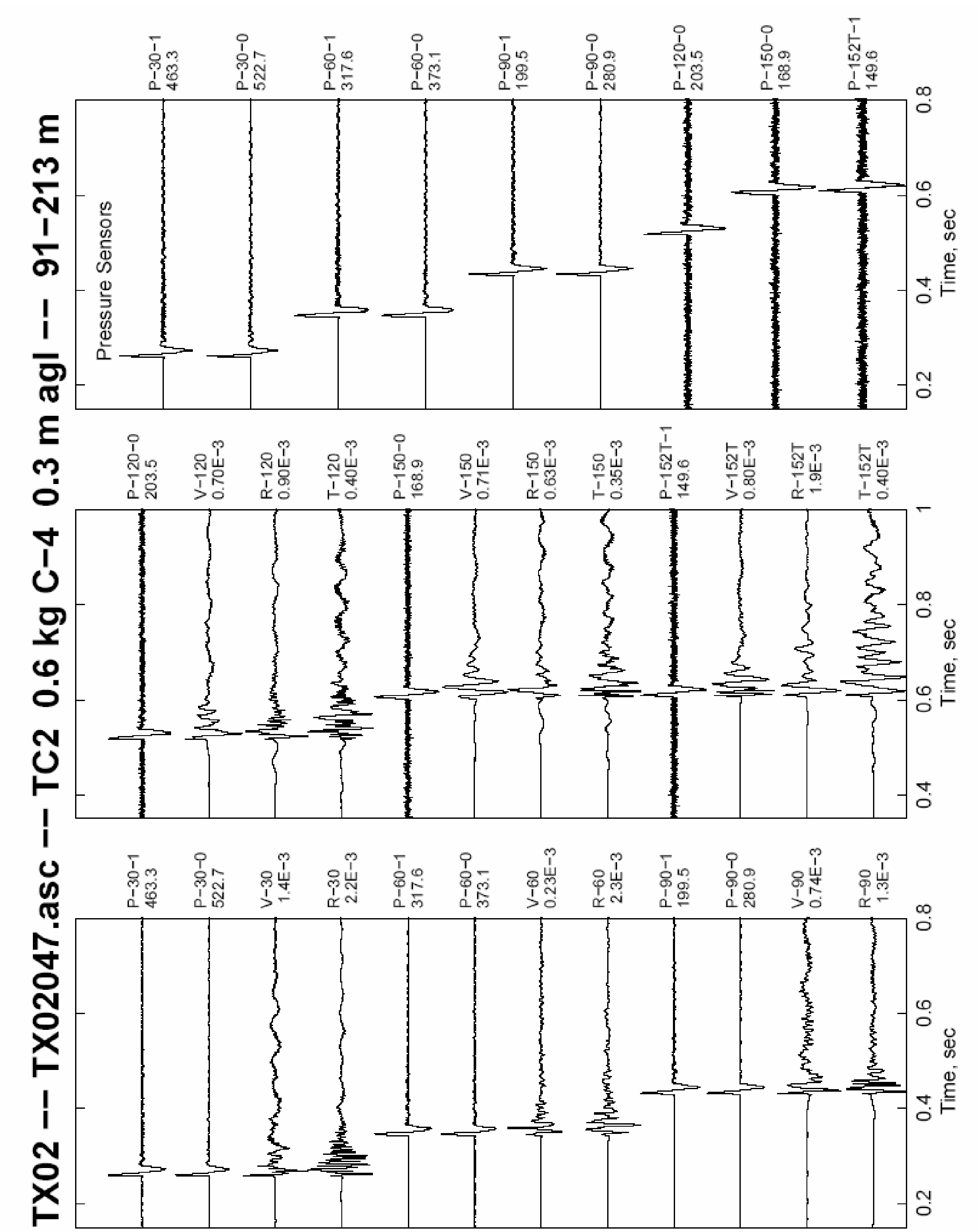

TX02 -- TX02037.asc -- TC2 2.3 kg C–4 0.3 m agl -- 91–213 m
Pressure Sensors
P–30–1 843.4
P–30–0 912.9
V–30 2.4E–3
R–30 3.7E–3
P–60–1 565.2
P–60–0 670.9
V–60 0.36E–3
R–60 2.8E–3
P–90–1 383.8
P–90–0 502.3
V–90 1.3E–3
R–90 1.9E–3
P–120–0 357.9
V–120 1.00E–3
R–120 1.4E–3
T–120 0.63E–3
P–150–0 316.9
V–150 1.2E–3
R–150 1.1E–3
T–150 0.65E–3
P–152T–1 293.0
V–152T 1.4E–3
R–152T 6.1E–3
T–152T 0.94E–3
Time, sec

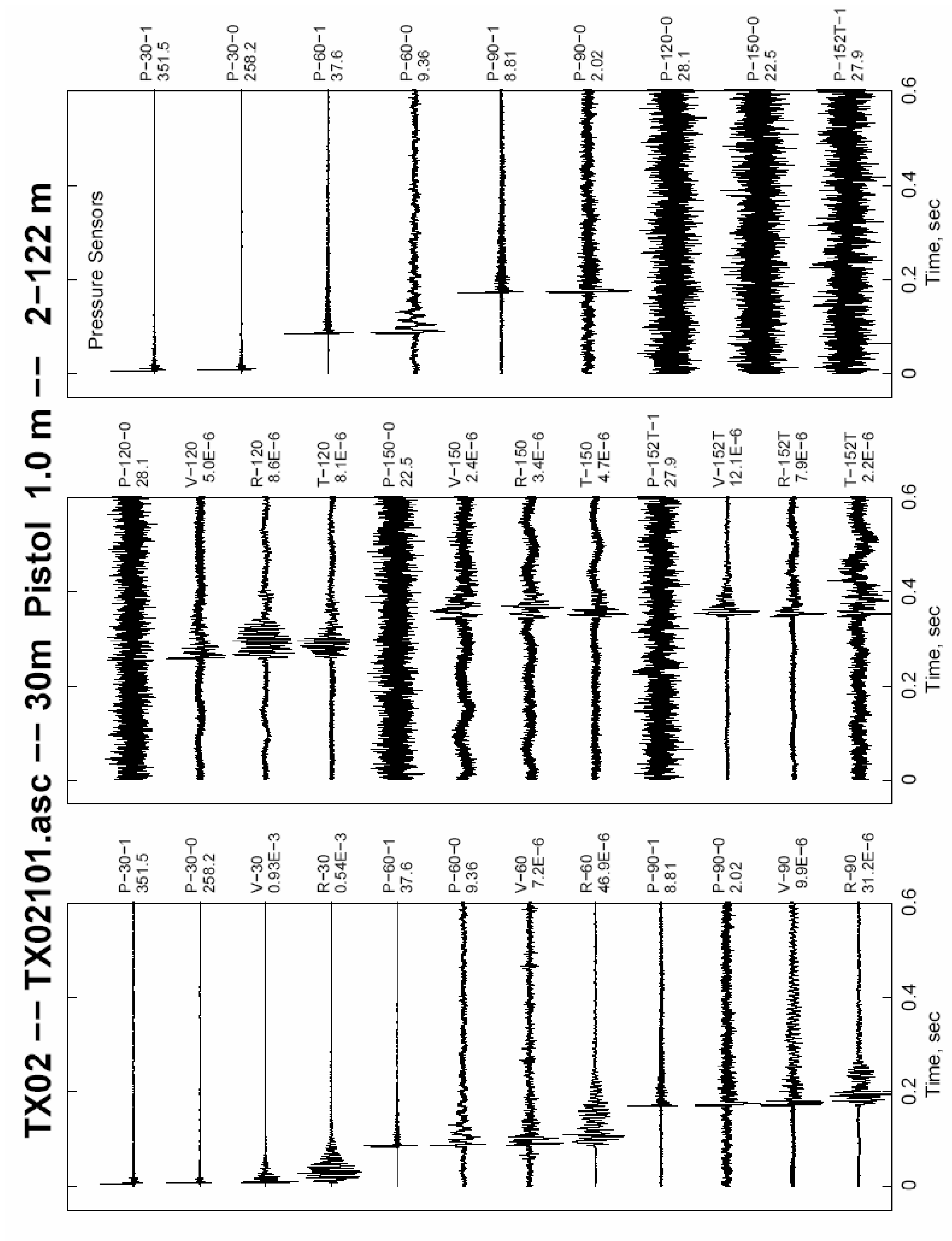

TX02 -- TX02043.asc -- TC2 0.6 kg C-4 3.8 m agl -- 91-213 m
P-30-1 430.4
P-30-0 572.9
V-30 1.2E-3
R-30 2.4E-3
P-60-1 383.2
P-60-0 425.8
V-60 0.27E-3
R-60 2.6E-3
P-90-1 232.6
P-90-0 314.0
V-90 0.76E-3
R-90 1.5E-3
Time, sec
P-120-0 213.0
V-120 0.80E-3
R-120 0.98E-3
T-120 0.40E-3
P-150-0 187.7
V-150 0.81E-3
R-150 0.68E-3
T-150 0.33E-3
P-152T-1 166.5
V-152T 0.85E-3
R-152T 2.3E-3
T-152T 0.46E-3
Time, sec
Pressure Sensors
P-30-1 430.4
P-30-0 572.9
P-60-1 383.2
P-60-0 425.8
P-90-1 232.6
P-90-0 314.0
P-120-0 213.0
P-150-0 187.7
P-152T-1 166.5
Time, sec

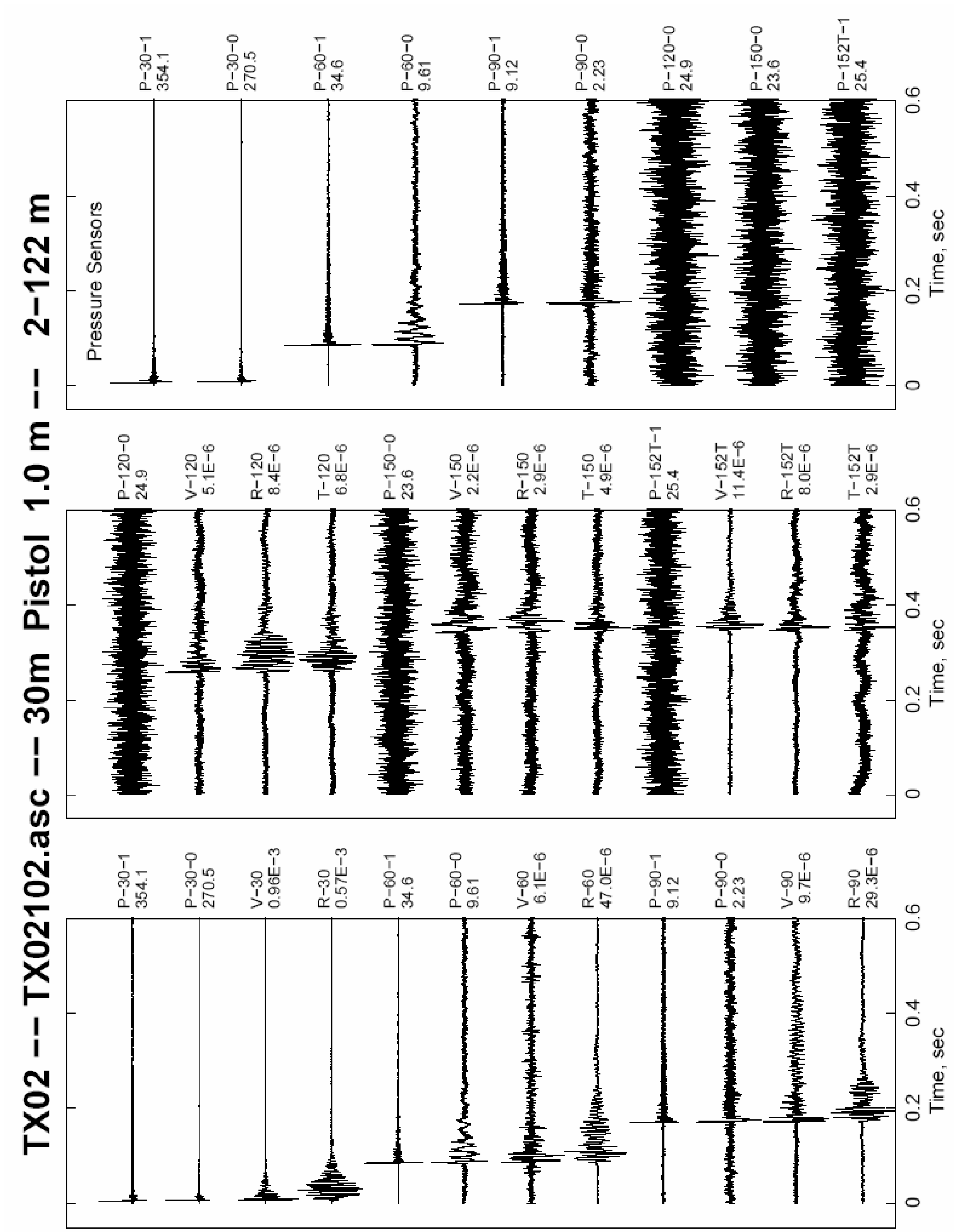

TX02 -- TX02044.asc -- TC2 0.6 kg C-4 3.8 m agl -- 91-213 m
Pressure Sensors
P-30-1 461.9
P-30-0 599.1
V-30 1.4E-3
R-30 2.6E-3
P-60-1 378.9
P-60-0 446.0
V-60 0.28E-3
R-60 2.6E-3
P-90-1 238.1
P-90-0 332.2
V-90 0.90E-3
R-90 1.6E-3
P-120-0 232.5
V-120 0.88E-3
R-120 1.1E-3
T-120 0.52E-3
P-150-0 195.4
V-150 0.84E-3
R-150 0.71E-3
T-150 0.47E-3
P-152T-1 183.6
V-152T 0.95E-3
R-152T 2.2E-3
T-152T 0.48E-3
Time, sec

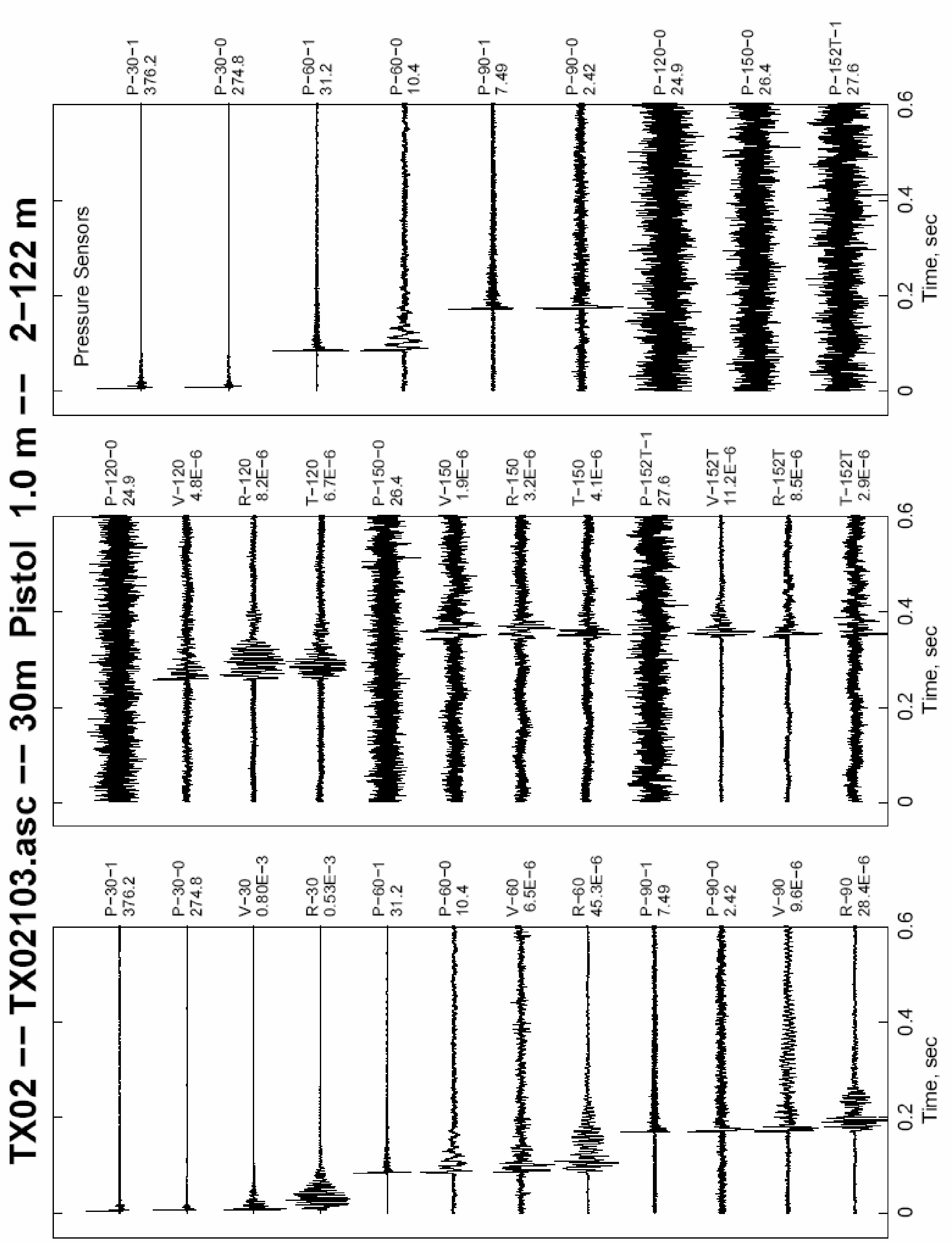

TX02 -- TX02045.asc -- TC2 0.6 kg C-4 3.0 m agl -- 91-213 m
Pressure Sensors
Time, sec
P-30-1 572.4
P-30-0 641.4
V-30 1.7E-3
R-30 2.9E-3
P-60-1 397.8
P-60-0 466.8
V-60 0.29E-3
R-60 3.0E-3
P-90-1 254.2
P-90-0 356.6
V-90 0.93E-3
R-90 1.7E-3
P-120-0 255.5
V-120 0.95E-3
R-120 1.2E-3
T-120 0.53E-3
P-150-0 222.2
V-150 0.95E-3
R-150 0.78E-3
T-150 0.45E-3
P-152T-1 214.0
V-152T 1.2E-3
R-152T 2.5E-3
T-152T 0.56E-3

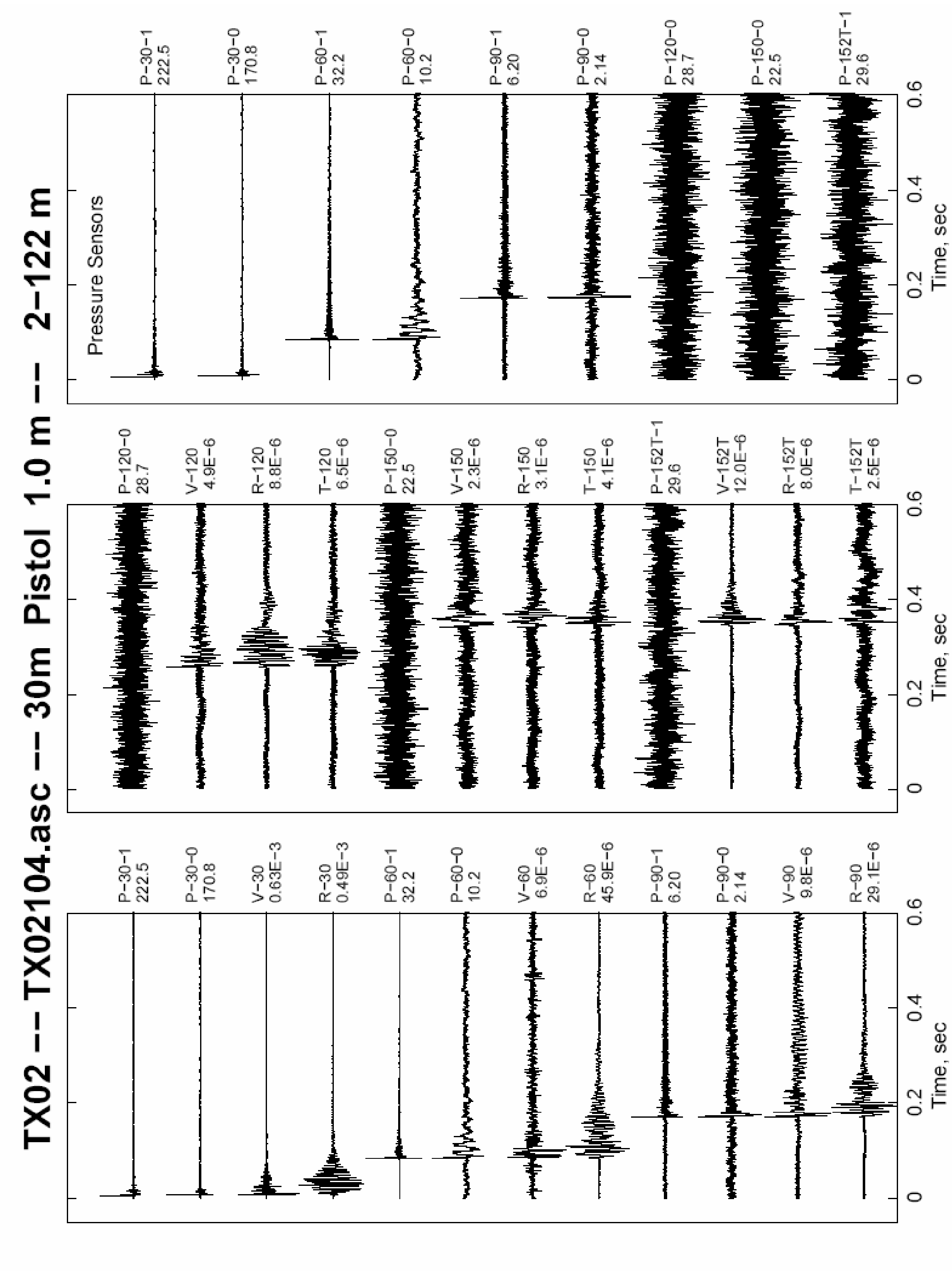

TX02 -- TX02046.asc -- TC2 0.6 kg C-4 1.2 m agl -- 91-213 m
Pressure Sensors
P-30-1 509.2
P-30-0 563.2
V-30 1.4E-3
R-30 2.4E-3
P-60-1 349.5
P-60-0 410.4
V-60 0.25E-3
R-60 2.6E-3
P-90-1 222.6
P-90-0 310.8
V-90 0.80E-3
R-90 1.5E-3
P-120-0 223.2
V-120 0.77E-3
R-120 1.00E-3
T-120 0.43E-3
P-150-0 191.5
V-150 0.78E-3
R-150 0.67E-3
T-150 0.36E-3
P-152T-1 176.7
V-152T 0.99E-3
R-152T 2.1E-3
T-152T 0.44E-3
Time, sec


TX02 -- TX02047.asc -- TC2 0.6 kg C-4 0.3 m agl -- 91-213 m
P-30-1 463.3
P-30-0 522.7
V-30 1.4E-3
R-30 2.2E-3
P-60-1 317.6
P-60-0 373.1
V-60 0.23E-3
R-60 2.3E-3
P-90-1 199.5
P-90-0 280.9
V-90 0.74E-3
R-90 1.3E-3
Time, sec
P-120-0 203.5
V-120 0.70E-3
R-120 0.90E-3
T-120 0.40E-3
P-150-0 168.9
V-150 0.71E-3
R-150 0.63E-3
T-150 0.35E-3
P-152T-1 149.6
V-152T 0.80E-3
R-152T 1.9E-3
T-152T 0.40E-3
Time, sec
Pressure Sensors
P-30-1 463.3
P-30-0 522.7
P-60-1 317.6
P-60-0 373.1
P-90-1 199.5
P-90-0 280.9
P-120-0 203.5
P-150-0 168.9
P-152T-1 149.6
Time, sec

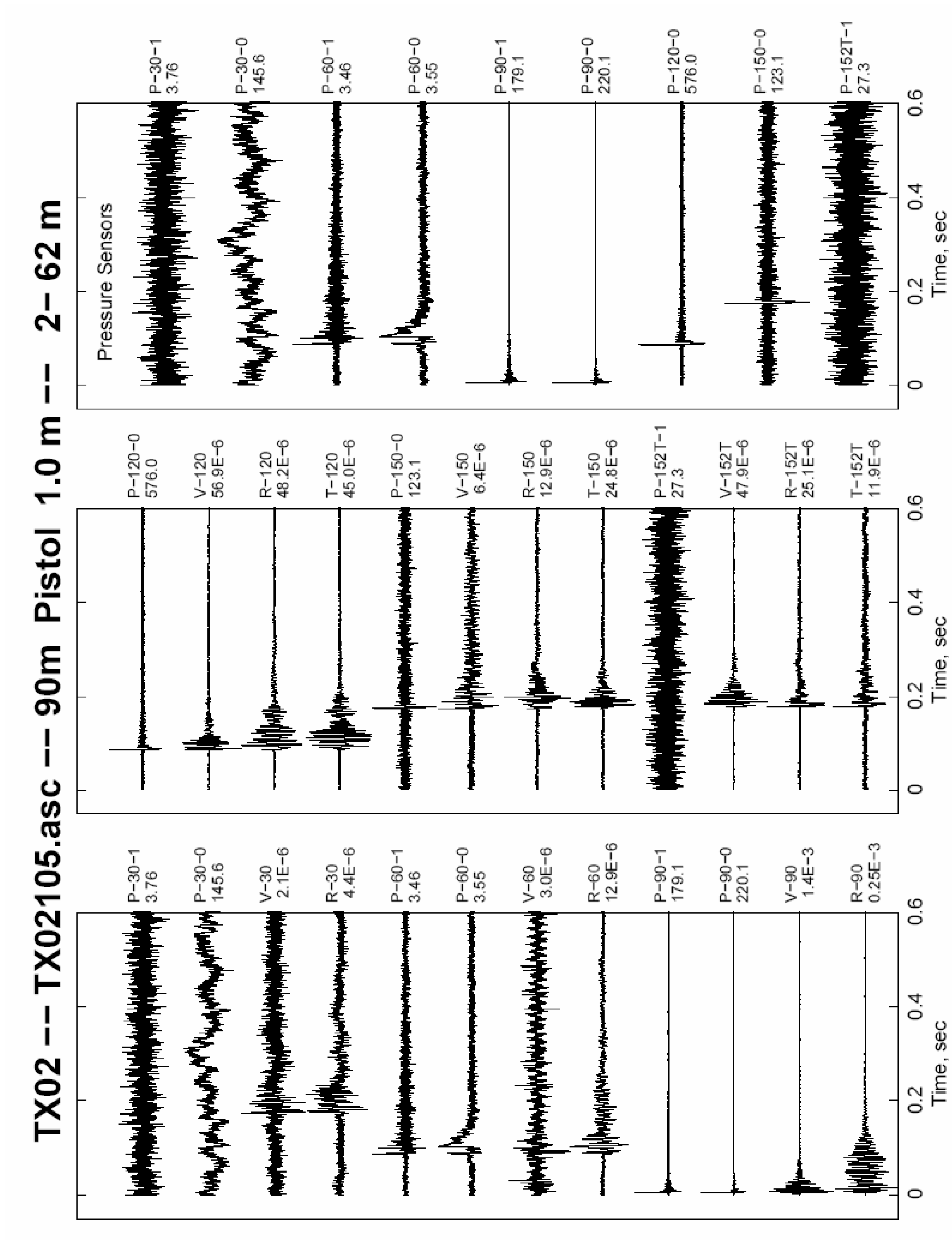

TX02 -- TX02101.asc -- 30m Pistol 1.0 m -- 2–122 m
Pressure Sensors
P–30–1 351.5
P–30–0 258.2
V–30 0.93E–3
R–30 0.54E–3
P–60–1 37.6
P–60–0 9.36
V–60 7.2E–6
R–60 46.9E–6
P–90–1 8.81
P–90–0 2.02
V–90 9.9E–6
R–90 31.2E–6
P–120–0 28.1
V–120 5.0E–6
R–120 8.6E–6
T–120 8.1E–6
P–150–0 22.5
V–150 2.4E–6
R–150 3.4E–6
T–150 4.7E–6
P–152T–1 27.9
V–152T 12.1E–6
R–152T 7.9E–6
T–152T 2.2E–6
Time, sec
0
0.2
0.4
0.6

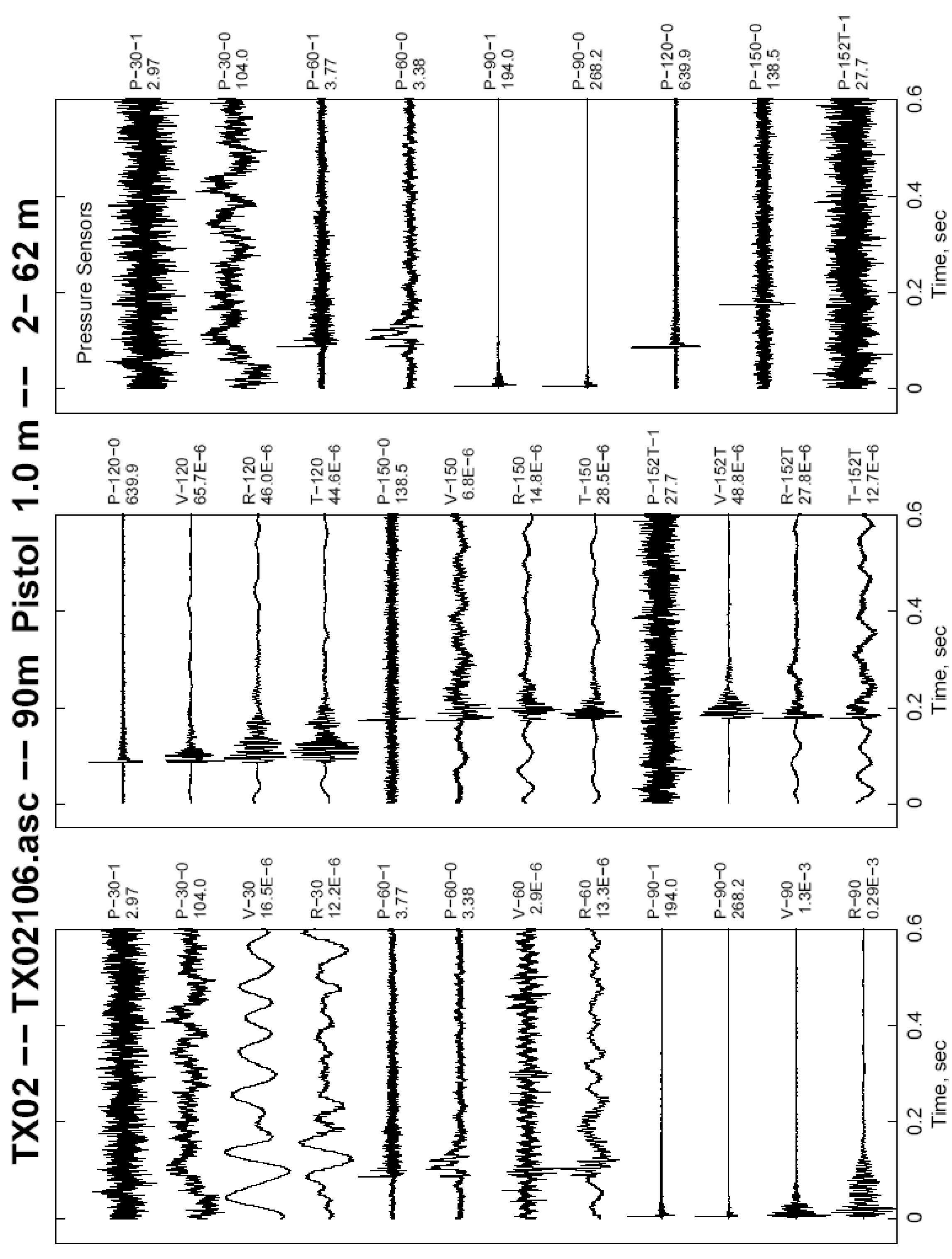

TX02 -- TX02102.asc -- 30m Pistol 1.0 m -- 2–122 m
P–30–1 354.1
P–30–0 270.5
V–30 0.96E–3
R–30 0.57E–3
P–60–1 34.6
P–60–0 9.61
V–60 6.1E–6
R–60 47.0E–6
P–90–1 9.12
P–90–0 2.23
V–90 9.7E–6
R–90 29.3E–6
Time, sec
P–120–0 24.9
V–120 5.1E–6
R–120 8.4E–6
T–120 6.8E–6
P–150–0 23.6
V–150 2.2E–6
R–150 2.9E–6
T–150 4.9E–6
P–152T–1 25.4
V–152T 11.4E–6
R–152T 8.0E–6
T–152T 2.9E–6
Time, sec
Pressure Sensors
P–30–1 354.1
P–30–0 270.5
P–60–1 34.6
P–60–0 9.61
P–90–1 9.12
P–90–0 2.23
P–120–0 24.9
P–150–0 23.6
P–152T–1 25.4
Time, sec
0
0.2
0.4
0.6


TX02 -- TX02103.asc -- 30m Pistol 1.0 m -- 2–122 m
P–30–1 376.2
P–30–0 274.8
V–30 0.80E–3
R–30 0.53E–3
P–60–1 31.2
P–60–0 10.4
V–60 6.5E–6
R–60 45.3E–6
P–90–1 7.49
P–90–0 2.42
V–90 9.6E–6
R–90 28.4E–6
P–120–0 24.9
V–120 4.8E–6
R–120 8.2E–6
T–120 6.7E–6
P–150–0 26.4
V–150 1.9E–6
R–150 3.2E–6
T–150 4.1E–6
P–152T–1 27.6
V–152T 11.2E–6
R–152T 8.5E–6
T–152T 2.9E–6
Pressure Sensors
0
0.2
0.4
0.6
Time, sec

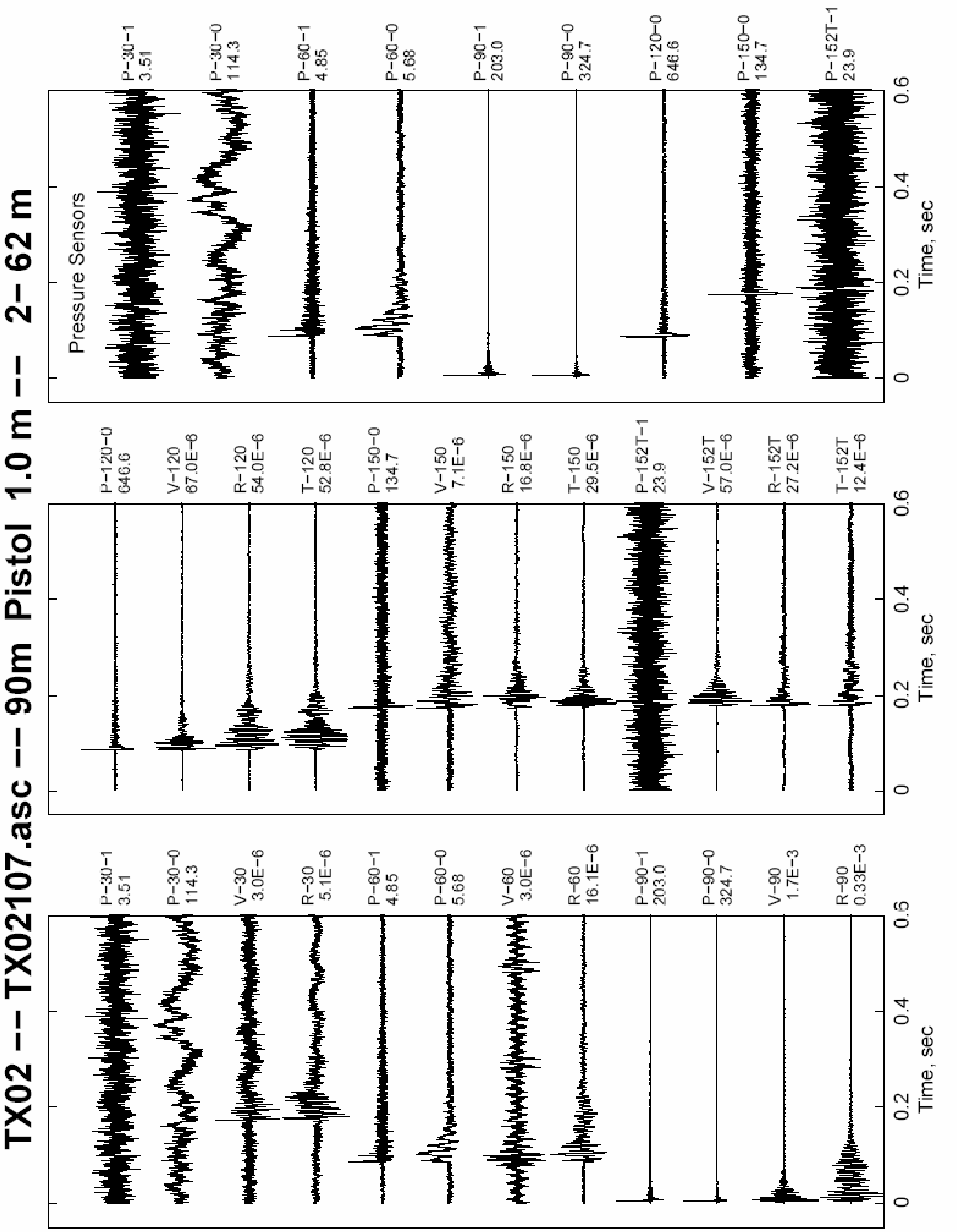


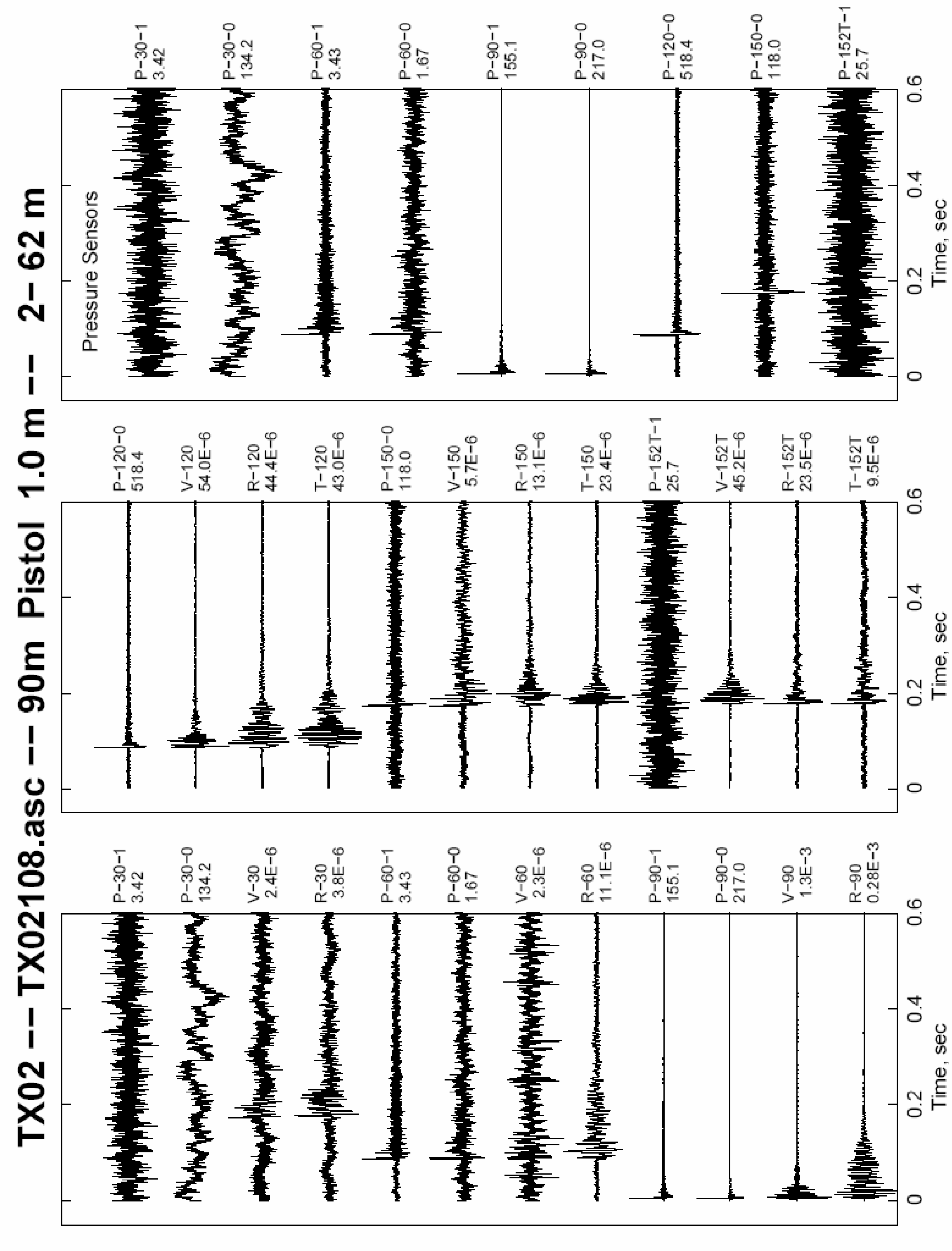
TX02 -- TX02104.asc -- 30m Pistol 1.0 m -- 2–122 m
Pressure Sensors
P–30–1 222.5
P–30–0 170.8
V–30 0.63E–3
R–30 0.49E–3
P–60–1 32.2
P–60–0 10.2
V–60 6.9E–6
R–60 45.9E–6
P–90–1 6.20
P–90–0 2.14
V–90 9.8E–6
R–90 29.1E–6
P–120–0 28.7
V–120 4.9E–6
R–120 8.8E–6
T–120 6.5E–6
P–150–0 22.5
V–150 2.3E–6
R–150 3.1E–6
T–150 4.1E–6
P–152T–1 29.6
V–152T 12.0E–6
R–152T 8.0E–6
T–152T 2.5E–6
Time, sec

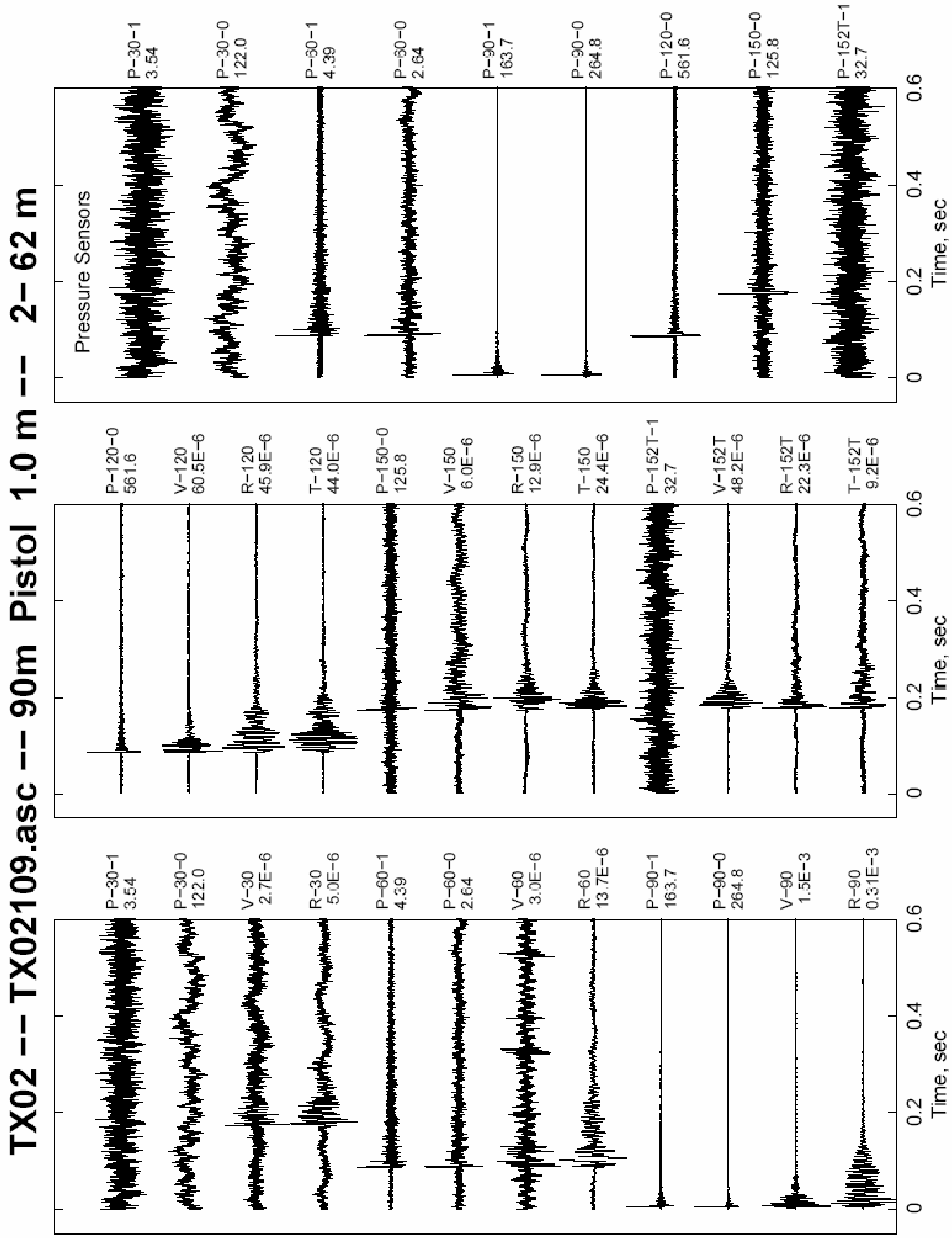

TX02 -- TX02105.asc -- 90m Pistol 1.0 m -- 2- 62 m
Pressure Sensors
P-30-1 3.76
P-30-0 145.6
P-60-1 3.46
P-60-0 3.55
P-90-1 179.1
P-90-0 220.1
P-120-0 576.0
P-150-0 123.1
P-152T-1 27.3
P-120-0 576.0
V-120 56.9E-6
R-120 48.2E-6
T-120 45.0E-6
P-150-0 123.1
V-150 6.4E-6
R-150 12.9E-6
T-150 24.8E-6
P-152T-1 27.3
V-152T 47.9E-6
R-152T 25.1E-6
T-152T 11.9E-6
P-30-1 3.76
P-30-0 145.6
V-30 2.1E-6
R-30 4.4E-6
P-60-1 3.46
P-60-0 3.55
V-60 3.0E-6
R-60 12.9E-6
P-90-1 179.1
P-90-0 220.1
V-90 1.4E-3
R-90 0.25E-3
0
0.2
0.4
0.6
Time, sec

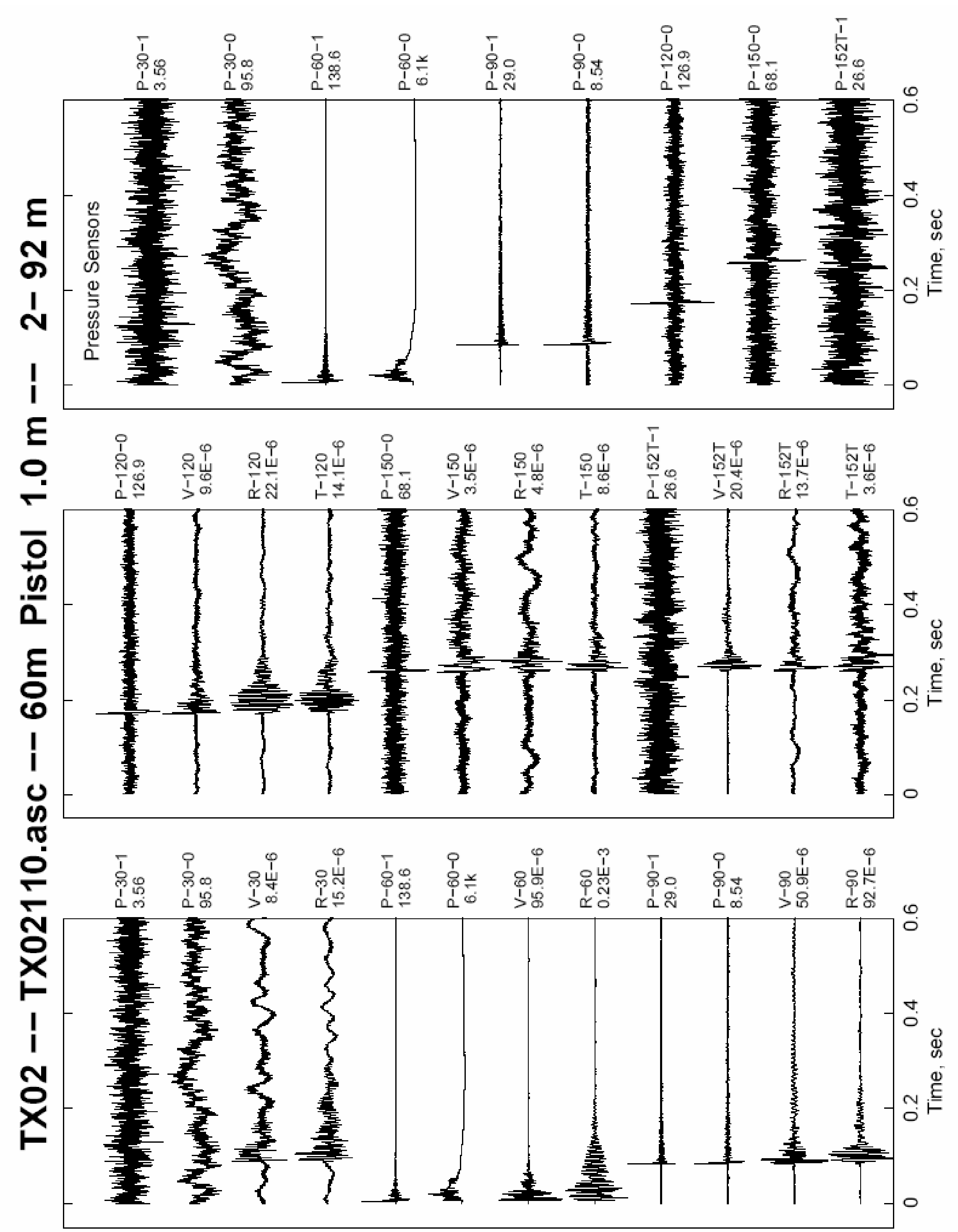


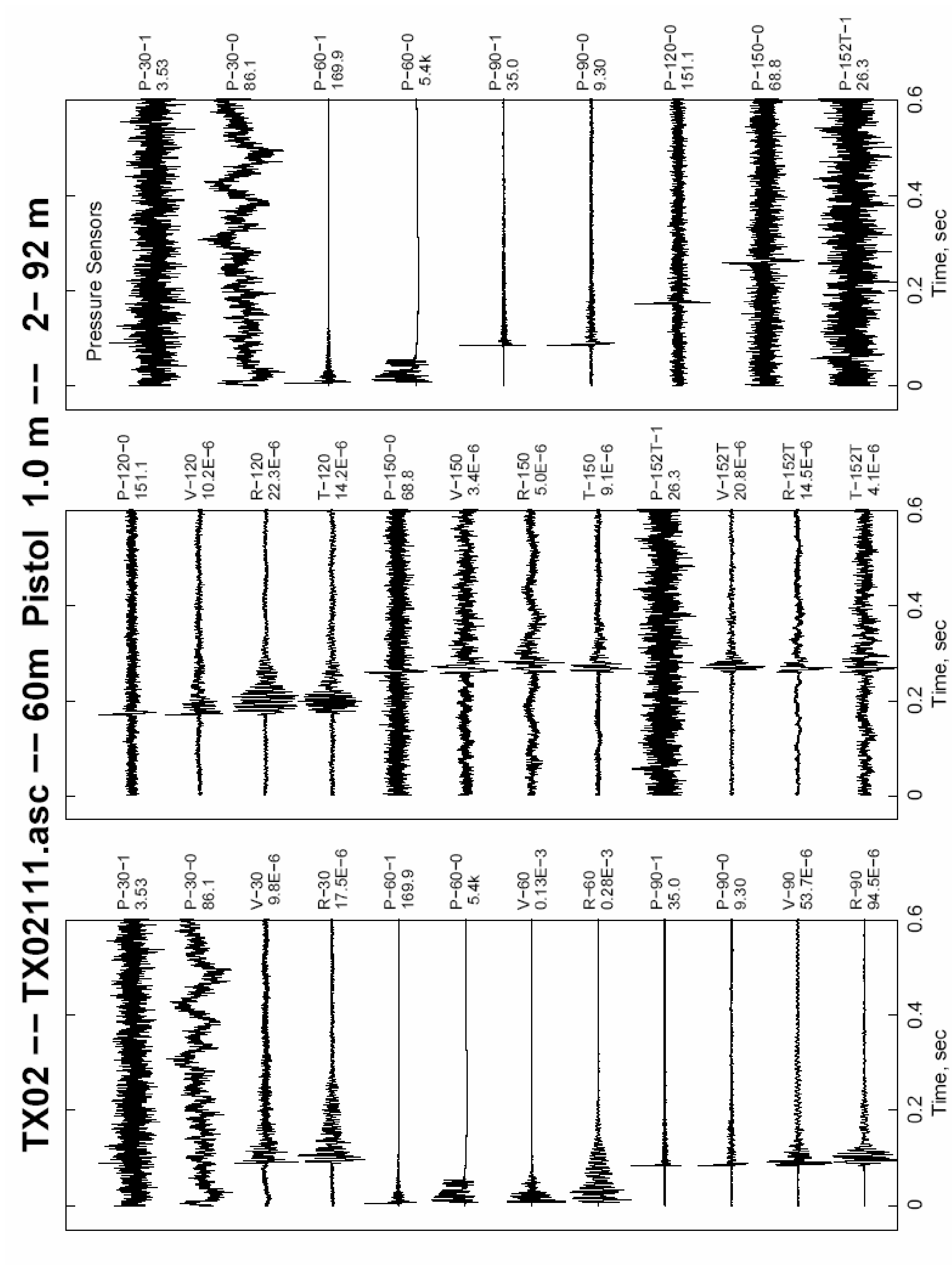
TX02 -- TX02106.asc -- 90m Pistol 1.0 m -- 2- 62 m
P−30−1 2.97
P−30−0 104.0
V−30 16.5E−6
R−30 12.2E−6
P−60−1 3.77
P−60−0 3.38
V−60 2.9E−6
R−60 13.3E−6
P−90−1 194.0
P−90−0 268.2
V−90 1.3E−3
R−90 0.29E−3
Time, sec
P−120−0 639.9
V−120 65.7E−6
R−120 46.0E−6
T−120 44.6E−6
P−150−0 138.5
V−150 6.8E−6
R−150 14.8E−6
T−150 28.5E−6
P−152T−1 27.7
V−152T 48.8E−6
R−152T 27.8E−6
T−152T 12.7E−6
Time, sec
Pressure Sensors
P−30−1 2.97
P−30−0 104.0
P−60−1 3.77
P−60−0 3.38
P−90−1 194.0
P−90−0 268.2
P−120−0 639.9
P−150−0 138.5
P−152T−1 27.7
Time, sec
0
0.2
0.4
0.6

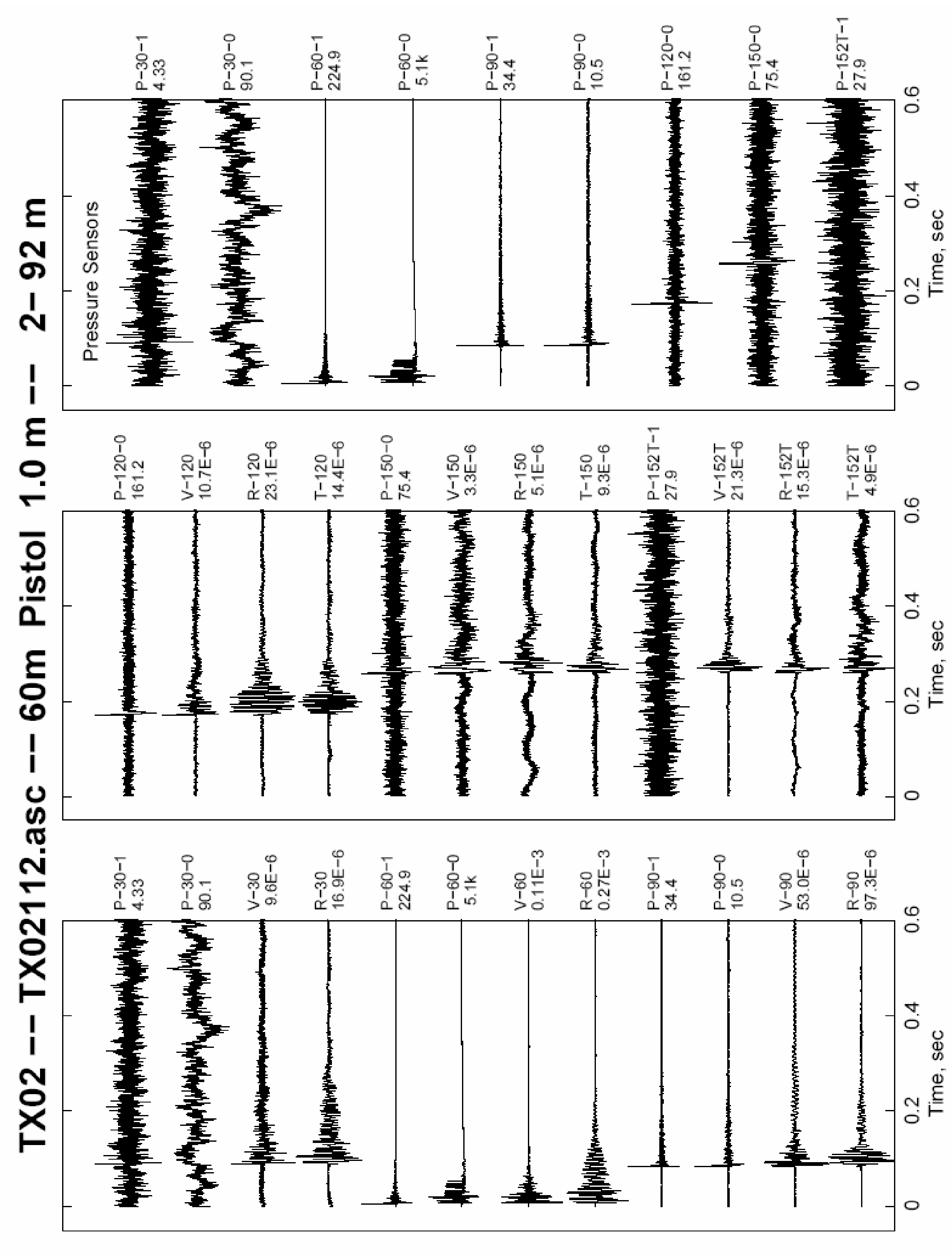

TX02 -- TX02107.asc -- 90m Pistol 1.0 m -- 2- 62 m
Pressure Sensors
P-30-1 3.51
P-30-0 114.3
P-60-1 4.85
P-60-0 5.68
P-90-1 203.0
P-90-0 324.7
P-120-0 646.6
P-150-0 134.7
P-152T-1 23.9
P-120-0 646.6
V-120 67.0E-6
R-120 54.0E-6
T-120 52.8E-6
P-150-0 134.7
V-150 7.1E-6
R-150 16.8E-6
T-150 29.5E-6
P-152T-1 23.9
V-152T 57.0E-6
R-152T 27.2E-6
T-152T 12.4E-6
P-30-1 3.51
P-30-0 114.3
V-30 3.0E-6
R-30 5.1E-6
P-60-1 4.85
P-60-0 5.68
V-60 3.0E-6
R-60 16.1E-6
P-90-1 203.0
P-90-0 324.7
V-90 1.7E-3
R-90 0.33E-3
0
0.2
0.4
0.6
Time, sec


TX02 -- TX02108.asc -- 90m Pistol 1.0 m -- 2- 62 m
P−30−1 3.42
P−30−0 134.2
V−30 2.4E−6
R−30 3.8E−6
P−60−1 3.43
P−60−0 1.67
V−60 2.3E−6
R−60 11.1E−6
P−90−1 155.1
P−90−0 217.0
V−90 1.3E−3
R−90 0.28E−3
Time, sec
P−120−0 518.4
V−120 54.0E−6
R−120 44.4E−6
T−120 43.0E−6
P−150−0 118.0
V−150 5.7E−6
R−150 13.1E−6
T−150 23.4E−6
P−152T−1 25.7
V−152T 45.2E−6
R−152T 23.5E−6
T−152T 9.5E−6
Time, sec
Pressure Sensors
P−30−1 3.42
P−30−0 134.2
P−60−1 3.43
P−60−0 1.67
P−90−1 155.1
P−90−0 217.0
P−120−0 518.4
P−150−0 118.0
P−152T−1 25.7
Time, sec

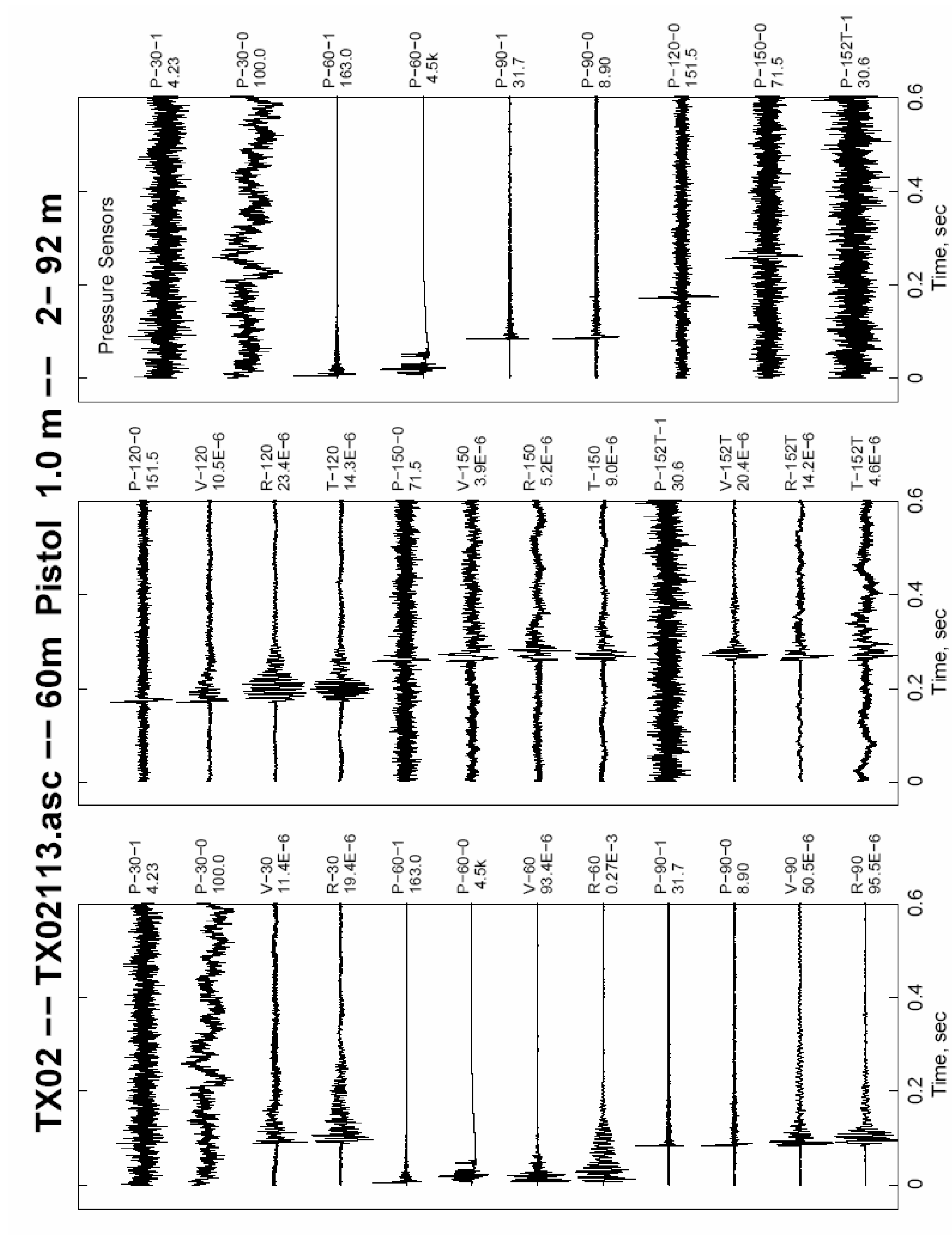

TX02 -- TX02109.asc -- 90m Pistol 1.0 m -- 2- 62 m
Pressure Sensors
P−30−1 3.54
P−30−0 122.0
P−60−1 4.39
P−60−0 2.64
P−90−1 163.7
P−90−0 264.8
P−120−0 561.6
P−150−0 125.8
P−152T−1 32.7
V−120 60.5E−6
R−120 45.9E−6
T−120 44.0E−6
V−150 6.0E−6
R−150 12.9E−6
T−150 24.4E−6
V−152T 48.2E−6
R−152T 22.3E−6
T−152T 9.2E−6
V−30 2.7E−6
R−30 5.0E−6
V−60 3.0E−6
R−60 13.7E−6
V−90 1.5E−3
R−90 0.31E−3
0
0.2
0.4
0.6
Time, sec

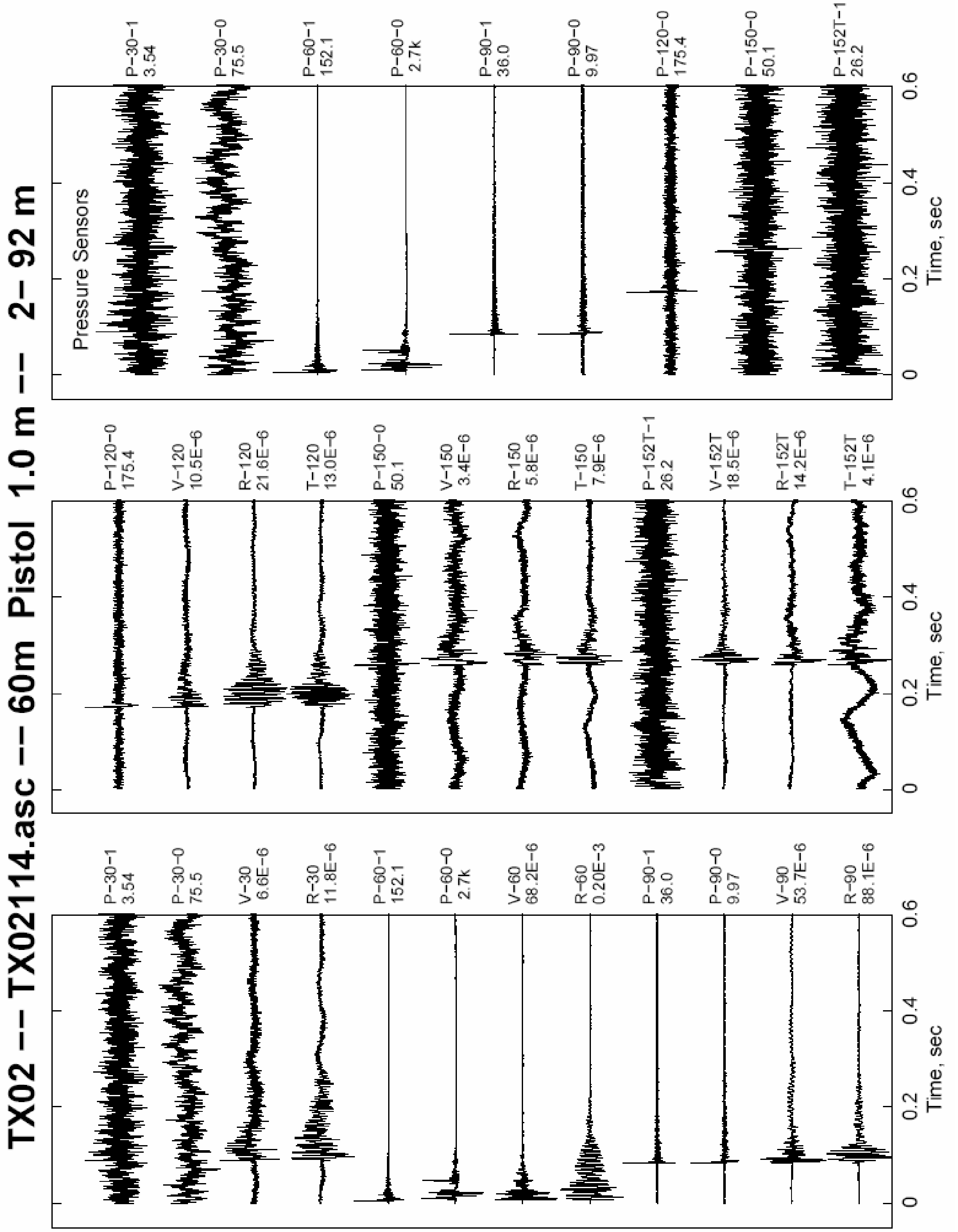

TX02 -- TX02110.asc -- 60m Pistol 1.0 m -- 2- 92 m
P-30-1 3.56
P-30-0 95.8
V-30 8.4E-6
R-30 15.2E-6
P-60-1 138.6
P-60-0 6.1k
V-60 95.9E-6
R-60 0.23E-3
P-90-1 29.0
P-90-0 8.54
V-90 50.9E-6
R-90 92.7E-6
P-120-0 126.9
V-120 9.6E-6
R-120 22.1E-6
T-120 14.1E-6
P-150-0 68.1
V-150 3.5E-6
R-150 4.8E-6
T-150 8.6E-6
P-152T-1 26.6
V-152T 20.4E-6
R-152T 13.7E-6
T-152T 3.6E-6
Pressure Sensors
P-30-1 3.56
P-30-0 95.8
P-60-1 138.6
P-60-0 6.1k
P-90-1 29.0
P-90-0 8.54
P-120-0 126.9
P-150-0 68.1
P-152T-1 26.6
0 0.2 0.4 0.6
Time, sec

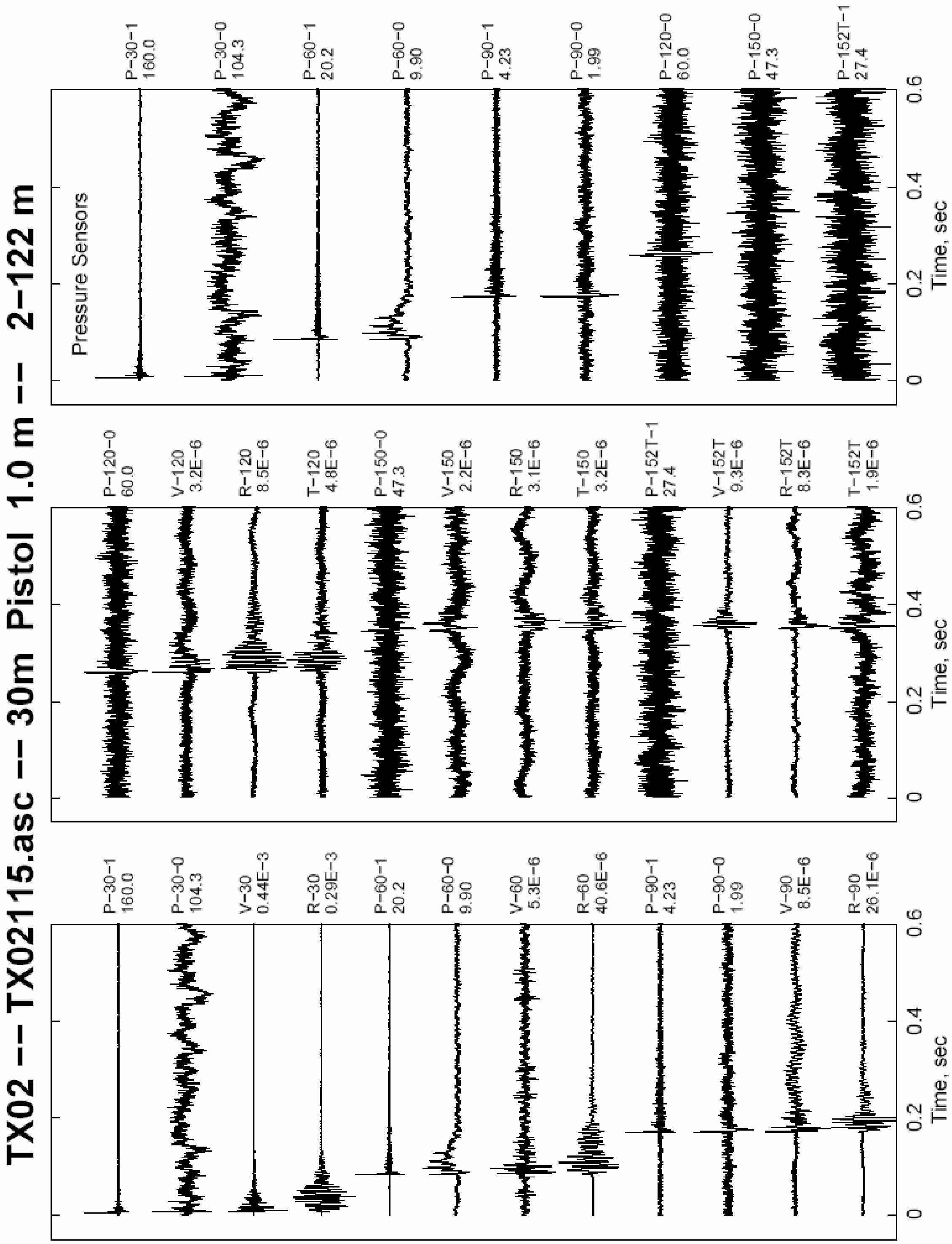

TX02 -- TX02111.asc -- 60m Pistol 1.0 m -- 2- 92 m
Pressure Sensors
P-30-1 3.53
P-30-0 86.1
P-60-1 169.9
P-60-0 5.4k
P-90-1 35.0
P-90-0 9.30
P-120-0 151.1
P-150-0 68.8
P-152T-1 26.3
V-120 10.2E-6
R-120 22.3E-6
T-120 14.2E-6
V-150 3.4E-6
R-150 5.0E-6
T-150 9.1E-6
V-152T 20.8E-6
R-152T 14.5E-6
T-152T 4.1E-6
V-30 9.8E-6
R-30 17.5E-6
V-60 0.13E-3
R-60 0.28E-3
V-90 53.7E-6
R-90 94.5E-6
0
0.2
0.4
0.6
Time, sec

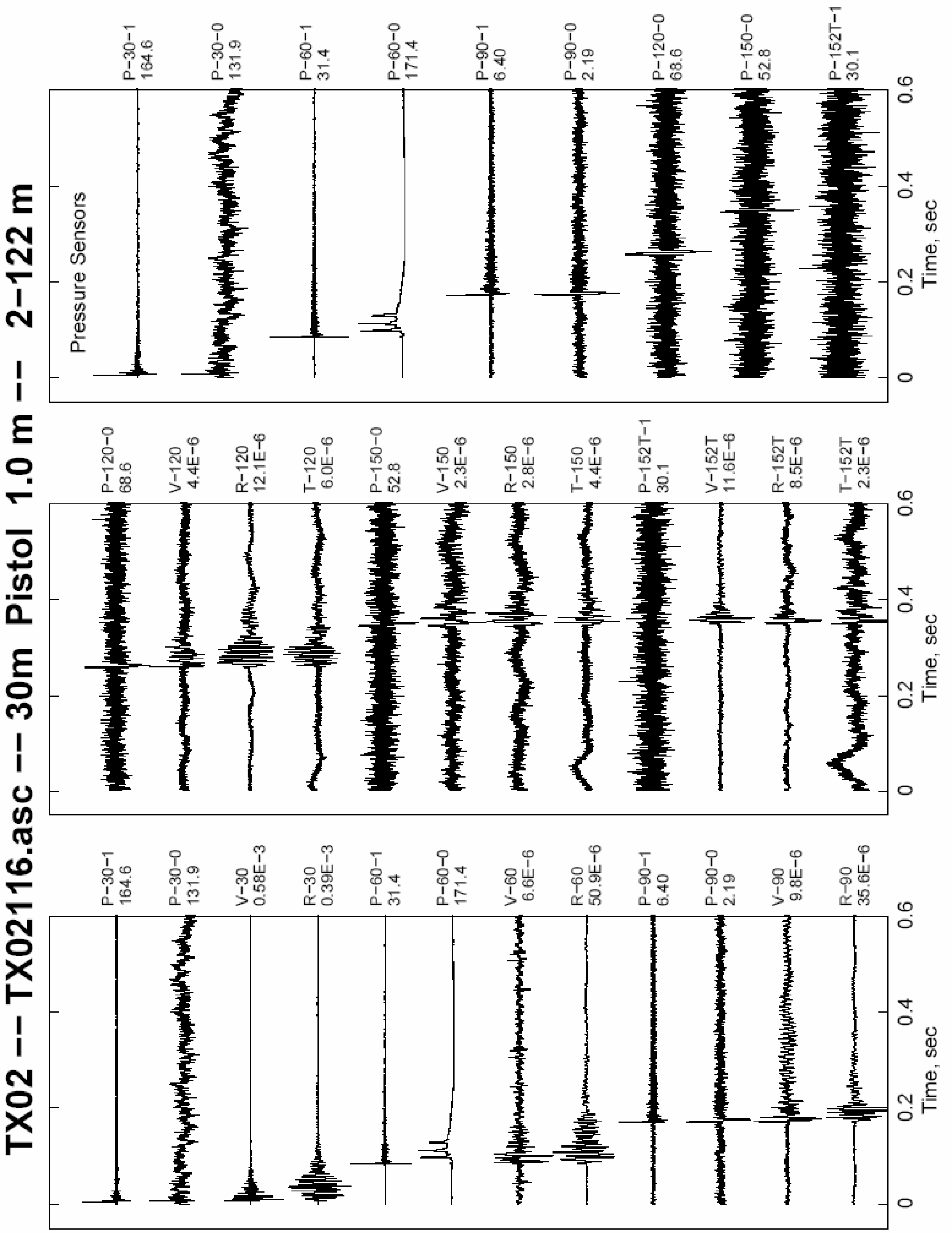


TX02 -- TX02112.asc -- 60m Pistol 1.0 m -- 2- 92 m
P−30−1 4.33
P−30−0 90.1
V−30 9.6E−6
R−30 16.9E−6
P−60−1 224.9
P−60−0 5.1k
V−60 0.11E−3
R−60 0.27E−3
P−90−1 34.4
P−90−0 10.5
V−90 53.0E−6
R−90 97.3E−6
Time, sec
P−120−0 161.2
V−120 10.7E−6
R−120 23.1E−6
T−120 14.4E−6
P−150−0 75.4
V−150 3.3E−6
R−150 5.1E−6
T−150 9.3E−6
P−152T−1 27.9
V−152T 21.3E−6
R−152T 15.3E−6
T−152T 4.9E−6
Time, sec
Pressure Sensors
P−30−1 4.33
P−30−0 90.1
P−60−1 224.9
P−60−0 5.1k
P−90−1 34.4
P−90−0 10.5
P−120−0 161.2
P−150−0 75.4
P−152T−1 27.9
Time, sec

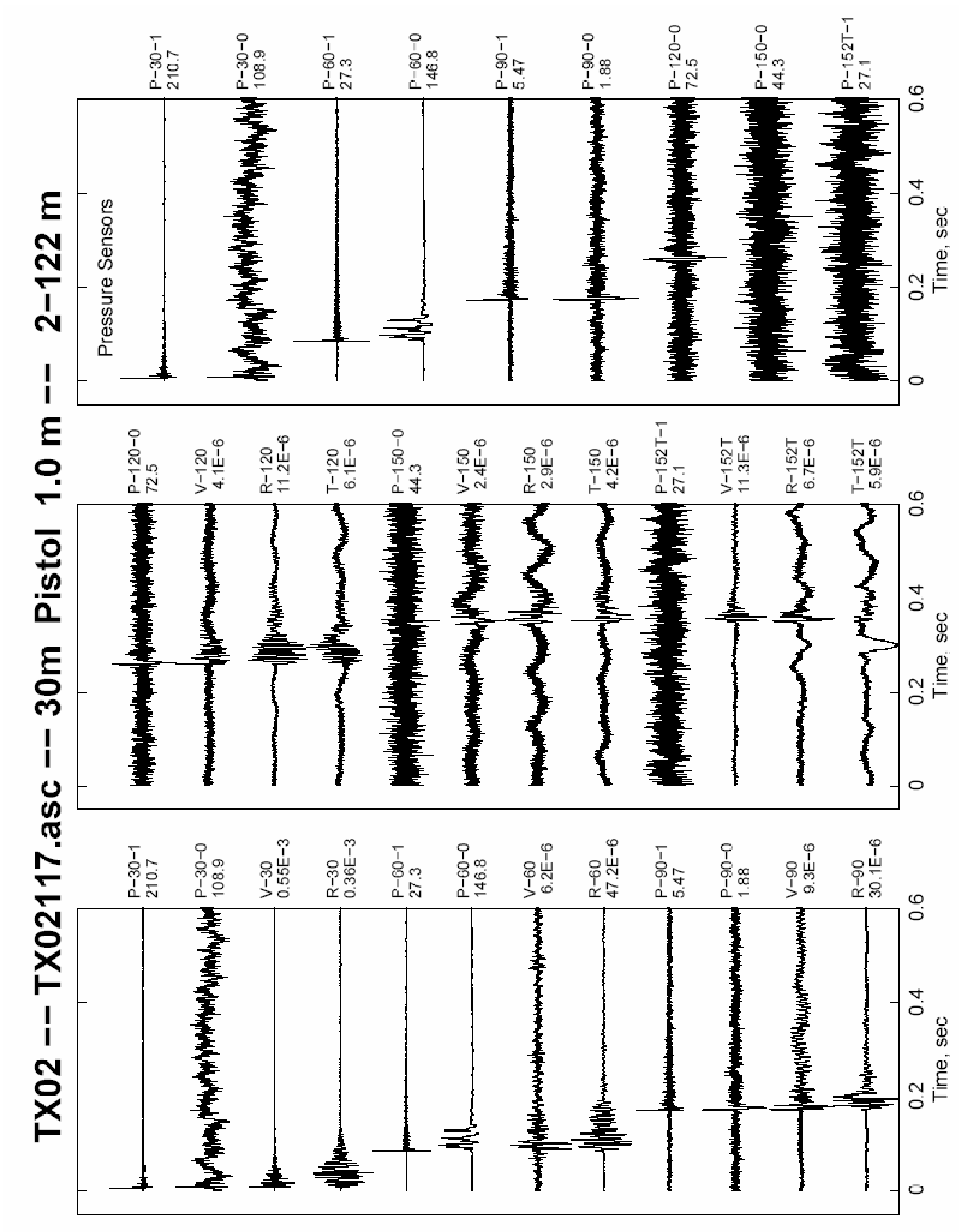

TX02 -- TX02113.asc -- 60m Pistol 1.0 m -- 2- 92 m
P-30-1 4.23
P-30-0 100.0
V-30 11.4E-6
R-30 19.4E-6
P-60-1 163.0
P-60-0 4.5k
V-60 93.4E-6
R-60 0.27E-3
P-90-1 31.7
P-90-0 8.90
V-90 50.5E-6
R-90 95.5E-6
P-120-0 151.5
V-120 10.5E-6
R-120 23.4E-6
T-120 14.3E-6
P-150-0 71.5
V-150 3.9E-6
R-150 5.2E-6
T-150 9.0E-6
P-152T-1 30.6
V-152T 20.4E-6
R-152T 14.2E-6
T-152T 4.6E-6
Pressure Sensors
Time, sec

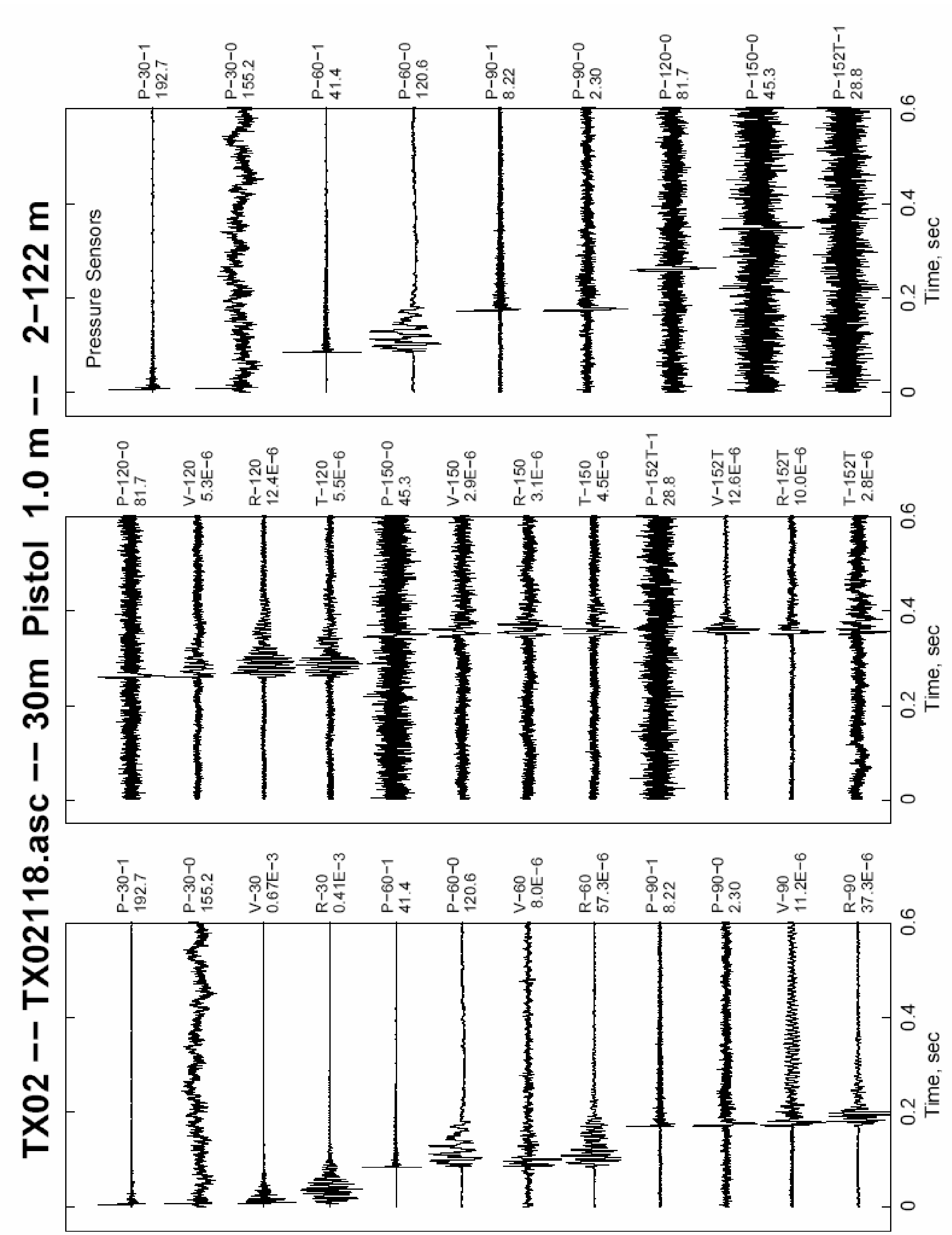

TX02 -- TX02114.asc -- 60m Pistol 1.0 m -- 2- 92 m
Pressure Sensors
P-30-1 3.54
P-30-0 75.5
P-60-1 152.1
P-60-0 2.7k
P-90-1 36.0
P-90-0 9.97
P-120-0 175.4
P-150-0 50.1
P-152T-1 26.2
V-120 10.5E-6
R-120 21.6E-6
T-120 13.0E-6
V-150 3.4E-6
R-150 5.8E-6
T-150 7.9E-6
V-152T 18.5E-6
R-152T 14.2E-6
T-152T 4.1E-6
V-30 6.6E-6
R-30 11.8E-6
V-60 68.2E-6
R-60 0.20E-3
V-90 53.7E-6
R-90 88.1E-6
0
0.2
0.4
0.6
Time, sec

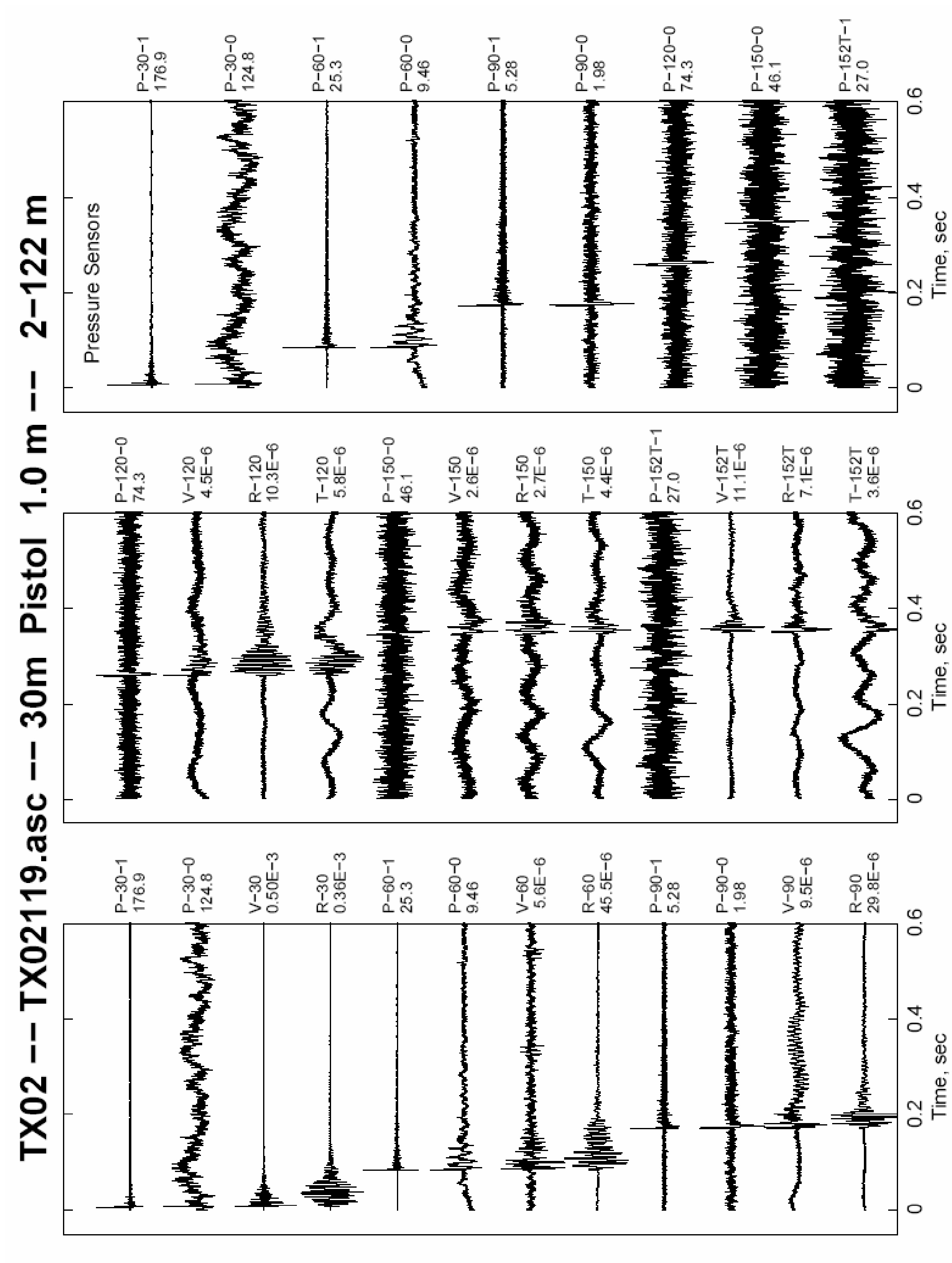

TX02 -- TX02115.asc -- 30m Pistol 1.0 m -- 2–122 m
P–30–1 160.0
P–30–0 104.3
V–30 0.44E–3
R–30 0.29E–3
P–60–1 20.2
P–60–0 9.90
V–60 5.3E–6
R–60 40.6E–6
P–90–1 4.23
P–90–0 1.99
V–90 8.5E–6
R–90 26.1E–6
P–120–0 60.0
V–120 3.2E–6
R–120 8.5E–6
T–120 4.8E–6
P–150–0 47.3
V–150 2.2E–6
R–150 3.1E–6
T–150 3.2E–6
P–152T–1 27.4
V–152T 9.3E–6
R–152T 8.3E–6
T–152T 1.9E–6
Pressure Sensors
P–120–0 60.0
P–150–0 47.3
P–152T–1 27.4
0
0.2
0.4
0.6
Time, sec



TX02 -- TX02116.asc -- 30m Pistol 1.0 m -- 2–122 m
Pressure Sensors
P–30–1 164.6
P–30–0 131.9
P–60–1 31.4
P–60–0 171.4
P–90–1 6.40
P–90–0 2.19
P–120–0 68.6
P–150–0 52.8
P–152T–1 30.1
V–120 4.4E–6
R–120 12.1E–6
T–120 6.0E–6
V–150 2.3E–6
R–150 2.8E–6
T–150 4.4E–6
V–152T 11.6E–6
R–152T 8.5E–6
T–152T 2.3E–6
V–30 0.58E–3
R–30 0.39E–3
V–60 6.6E–6
R–60 50.9E–6
V–90 9.8E–6
R–90 35.6E–6
0 0.2 0.4 0.6
Time, sec


TX02 -- TX02117.asc -- 30m Pistol 1.0 m -- 2–122 m
Pressure Sensors
P–30–1 210.7
P–30–0 108.9
P–60–1 27.3
P–60–0 146.8
P–90–1 5.47
P–90–0 1.88
P–120–0 72.5
P–150–0 44.3
P–152T–1 27.1
V–120 4.1E–6
R–120 11.2E–6
T–120 6.1E–6
V–150 2.4E–6
R–150 2.9E–6
T–150 4.2E–6
V–152T 11.3E–6
R–152T 6.7E–6
T–152T 5.9E–6
V–30 0.55E–3
R–30 0.36E–3
V–60 6.2E–6
R–60 47.2E–6
V–90 9.3E–6
R–90 30.1E–6
Time, sec
0
0.2
0.4
0.6


TX02 -- TX02118.asc -- 30m Pistol 1.0 m -- 2−122 m
P−30−1 192.7
P−30−0 155.2
V−30 0.67E−3
R−30 0.41E−3
P−60−1 41.4
P−60−0 120.6
V−60 8.0E−6
R−60 57.3E−6
P−90−1 8.22
P−90−0 2.30
V−90 11.2E−6
R−90 37.3E−6
P−120−0 81.7
V−120 5.3E−6
R−120 12.4E−6
T−120 5.5E−6
P−150−0 45.3
V−150 2.9E−6
R−150 3.1E−6
T−150 4.5E−6
P−152T−1 28.8
V−152T 12.6E−6
R−152T 10.0E−6
T−152T 2.8E−6
Pressure Sensors
P−30−1 192.7
P−30−0 155.2
P−60−1 41.4
P−60−0 120.6
P−90−1 8.22
P−90−0 2.30
P−120−0 81.7
P−150−0 45.3
P−152T−1 28.8
0 0.2 0.4 0.6
Time, sec


TX02 -- TX02119.asc -- 30m Pistol 1.0 m -- 2-122 m
Pressure Sensors
P-30-1 176.9
P-30-0 124.8
P-60-1 25.3
P-60-0 9.46
P-90-1 5.28
P-90-0 1.98
P-120-0 74.3
P-150-0 46.1
P-152T-1 27.0
P-120-0 74.3
V-120 4.5E-6
R-120 10.3E-6
T-120 5.8E-6
P-150-0 46.1
V-150 2.6E-6
R-150 2.7E-6
T-150 4.4E-6
P-152T-1 27.0
V-152T 11.1E-6
R-152T 7.1E-6
T-152T 3.6E-6
P-30-1 176.9
P-30-0 124.8
V-30 0.50E-3
R-30 0.36E-3
P-60-1 25.3
P-60-0 9.46
V-60 5.6E-6
R-60 45.5E-6
P-90-1 5.28
P-90-0 1.98
V-90 9.5E-6
R-90 29.8E-6
Time, sec

APPENDIX B: MATLAB PROGRAMS TO READ AND PLOT BINARY DATA FROM NZ SEISMOGRAPH AND TO WRITE MULTICHANNEL ASCII DATA FILES.

This section provides a listing of the MATLAB programs used to read and plot the 24 binary data files recorded by the Geometrics NZ seismograph in SEG-2 format. The programs convert the seismograph voltages to physical units before plotting. The programs also correct errors in the shot time (due to a malfunction of the shot box) and write the corrected data to multichannel ASCII data files that can be plotted using the programs listed in the next section of this report. These ASCII files serve as the permanent archive format for the test data. The files that are listed in this section are:

1. **tx02doprocessnz.m**—Main program to read binary data files and write multichannel ASCII files. To use, set the desired binary file numbers in the variable "recs" and run the program. You may have to change the lines that construct the filenames to use the correct directory for your computer, and you may want to change the print options at the very end of this program to match your printer or delete the plot from the screen after plotting. The program will write an ASCII file with a new record number that either matches the CERL shot number (for C4 explosions) or a new pistol shot number between 101 and 119. Writes the pressure sensor info to text file TX02MikeLog.m. Calls the programs listed below.
2. **readnz.m**—Function to read the SEG-2 binary file produced by the NZ seismograph. Calls words.m. Writes info to the text file readnzlog.m.
3. **tx02cerlnum.m**—Function to select the CERL C4 shot number or new pistol shot number from the binary file number.
4. **tx02label.m**—Function to get all of the experimental details including which sensor was attached to which channel, voltage-to-physical-units conversion factors, sensor and shot point geometry and distances, which source used for each file, etc. Calls words.m.
5. **tx02plotnz.m**—Function to make a three-panel plot of the binary data in landscape orientation. The channels plotted in each of the panels are given by the contents of iplot1, iplot2, and iplot3. These plots show the uncorrected times in the binary files, i.e., when the recorder button was pushed, not when the shot was actually fired.
6. **tx02tbcorr.m**—Function to find the true time break (shot instant). This is done using the arrival times from the first and last sensor in the array to determine the acoustic wave velocity, and then projecting back to zero

distance to get the origin time. Writes the time break info to file Tx02TimeBreakLog.m and applies the correction to the multichannel ASCII data files.

7. **tx02writenchan.m**—Function to write multichannel ASCII data file with 12 line trace headers. The ASCII file name is tx02nnn.asc, where nnn is a new file number. nnn = CERL shot number if it was a C4 shot.
8. **words.m**—Function to separate a string into individual words by finding the blank characters.

tx02doprocessnz.m—Main program to plot binary data and write multichannel ASCII file

```
% d:\DataWinNT\FY02LoneStarTX\Plot\tx02doprocessnz.m
% Processes TX02 NZ seismograph data:
% Reads NZ data (x) -- writes file info to readnzlog.m
% Converts to eng units (xx)
% Finds CERL rec number (nnn)
% Plots data - 3 panels
% Finds the true time break - writes in Tx02TimeBreakLog.m
% Writes pressure data info to Tx02MikeLog.m
% Writes multichannel ascii file to tx02nnn.asc
% Calls subroutines
% readnz words tx02cerlnum
% tx02plotnz tx02label tx02tbcorr
% tx02writenchan

% d:\DataWinNT\FY02LoneStarTX\Plot\tx02doprocessnz.m
% Reads NZ seismograph binary records, makes 3 panel plots of data
% Writes pressure sensor info to Tx02MikeLog.m
%
% Calls functions
% readnz.m - to read the SEG-2 binary data using the
% CRREL field record numbers
% words.m - to parse ascii header lines into words
% Writes info about the file to file readnzlog.m
% tx02cerlnum.m - selects CERL shot number or new pistol shot number
% calls no subroutines
% tx02label.m - to get sensor geometry, etc
% calls words.m
% tx02plotnz.m - 3 Panel plot of data
% calls no subroutines
% tx02tbcorr.m - Finds true time break (shot instant)
```

```
% from the arrival times at a few of the sensors
% Writes info to Tx02TimeBreakLog.m
% calls no subroutines
% tx02writenchan.m - writes multichannel ascii data with 12 line trace
headers
% File name is tx02nnn.asc, where nnn is a new file number
% nnn = CERL Shot number if it was a C-4 shot
% calls no subroutines

% Don Albert dalbert@crrel.usace.army.mil
% USA ERDC-CRREL, 72 Lyme Road, Hanover, NH 03755


% NZ binary record numbers; plot has new record number in title
% C-4 Records 39,44 were bad and are omitted
%recs = [65 66 67 68 5]; %TX02 C-4 examples and blank pistol shot
example
%recs = [ 3 5 10 15]; %Blank pistol shot examples
%recs = [ 40:43 60:68 70:74 93:113 1:19]; %All C-4 39,44 bad and all
blank pistol
recs = [ 40:43 60:68 70:74 93:113 1:19]; %All C-4 39,44 bad and all
blank pistol
recs = [64 65];

% Loop to plot the files
for i = 1:length(recs); % ****************************************
 xx=[];x=[];
 recnum = recs(i);
 shotnum = recs(i);
 fname = sprintf('d:\\DataWinNT\\fy02texas\\%s.dat',num2str(recnum));

% read in data from NZ binary file - x
 [x,npts,deltat,nchan,delayms,descalingfact,...
 stackcount,acqdate,acqtime] = readnz(fname);
% sample rate
 srate = 1/ deltat;%number of samples per second

% Get geometry and description for this experiment and record number
 [sensor,sensortype,rtype,sensorx,sensory,sensorz,...
 srcloc,sourcetype,stype,srcx,srcy,srcz,sourcesize,...
 engfact,dist,sensor2,source2] = tx02label (x,shotnum,nchan);
```

```
% Convert from voltage to physical units (Pa or m/s)
 xgain = descalingfact./(stackcount.*engfact); %recorder units to eng
units
 for iii = 1:nchan; xx(:,iii) = x(:,iii) * xgain(iii); end
 xxmax = max(abs(xx)); %abs max for plotting

% get CERL record number for C-4 shots
 cerlrec = 0;
 [cerlrec ] = tx02cerlnum (shotnum);%If C-4 get CERL Shot Number for
Plot

% 3 panel plot of nz data
 iplot1 = [9 10 11 12 5 6 7 8 1 2 3 4]; %Channels for 1st (left) panel
 iplot2 = [22 21 23 24 18 17 19 20 14 13 15 16 ];% 2nd (center) panel
 iplot3 = [24 20 16 11 12 7 8 3 4];%Channels for 3rd (right) panel
 tx02plotnz(shotnum,cerlrec,xx,iplot1,iplot2,iplot3,deltat,delayms,...
 dist,sensor,sensorx,sensory,sensorz,...
 srcloc,sourcesize,sourcetype,srcx,srcy,srcz);

% Write pressure sensor data to text file
 fid3=fopen('Tx02MikeLog.m','a');
 iplot = iplot3; nplot=length(iplot3);
% Write pressure sensor trace header info to logfile
 [aa bb] = max(xx); %set plot windows because manual TB
 [cc dd] = min(xx); %set plot windows because manual TB
 for iii =1:nplot;
 tttmax = delayms/1000 + (bb(iplot(iii)) )/srate; %times in seconds
 tttmin = delayms/1000 + (dd(iplot(iii)) )/srate; %times in seconds
 fprintf(fid3,...
 ' %4.0f %3.0f %3.0f %3.1f %5.0f %3.1f %3.1f %6.1f %6.1f %6.4f %6.1f
%6.4f %6.4f \n',...
 shotnum,iplot(iii),sensorx(iplot(iii)),sensorz(iplot(iii)),...
 srcx,srcz,sourcesize*1.25/2.2,...
 dist(iplot(iii)),aa(iplot(iii)),tttmax,cc(iplot(iii)),tttmin,(tttmin-
tttmax));
 end
 fclose(fid3);

% Find TB correction - writes to output file xxxTimebreaklog.m
```

```
% itimeTB is the TB (shot instant) index
% itime0 is the index to start the save (usually=TB)
% if the shot was at TC1, 1 second is added to itime0
% itime1 is the index 2 seconds after the TB
% time0 is the start time for saving the time series

 [itimeTB,itime0,itime1,time0,xdist,xtime] = tx02tbcorr(shotnum,...
 cerlrec,xx,deltat,delayms,srcloc);

% Write engineering data to ascii file
tx02writenchan(shotnum,cerlrec,xx,npts,deltat,nchan,delayms,descalingfac
t,...
 stackcount,acqdate,acqtime,engfact,xgain,itime0,itime1,time0,...
 dist,sensor,rtype,sensorx,sensory,sensorz,sensor2,...
 srcloc,stype,sourcetype,sourcesize,srcx,srcy,srcz,source2);

% Print and delete
% print -dljetplus;
% print -dljetplus; pause(25); h=gcf; delete(h);
% print to PostScript file for conversion to PDF:
% print -dps -r150 -append tx02datafigs
% h=gcf;delete(h);

end %loop over files % ****************************************
 fclose('all');

return
```

tx02label.m—Provides info about sensor array and sources

```
function [sensor,sensortype,rtype,sensorx,sensory,sensorz,...
 srcloc,sourcetype,stype,srcx,srcy,srcz,sourcesize,...
 engfact,dist,sensor2,source2] = tx02label (x,shotnum,nchan)

% d:\DataWinNT\FY02LoneStarTX\tx02label.m
% Returns channel ids for NZ seismograph used at FY02 TX test
% calls words.m - breaks string into individual words

% Don Albert dalbert@crrel.usace.army.mil
% USA ERDC-CRREL, 72 Lyme Road, Hanover, NH 03755
```

```
% Assign sensor coordinates
% sensorx = (1:nchan)*1; sensorz(1:nchan) = 0;
sensorx = (1:nchan)*0; sensory = (1:nchan)*0; sensorz = (1:nchan)*0;
sensorx = [30,30,30,30, 60,60,60,60, 90,90,90,90, ...
 120,120,120,120, 150,150,150,150, 152,152,152,152];

height15 = [4,8,12,24]; sensorz(height15) = 1.5;
height2 = [3,7,11]; sensorz(height2) = 0.08;
height3 = [16,20]; sensorz(height3) = 0.22;

% Assign sensortype
for i = 1:nchan; sensortype(i)='P'; end
senv = [2 6 10 15 19 23 ]; sensortype(senv)='V';
senr = [1 5 9 13 17 21 ]; sensortype(senr)='R';
sent = [ 14 18 22 ]; sensortype(sent)='T';

sss = ['R-30 V-30 P-30-0 P-30-1 R-60 V-60 P-60-0 P-60-1 ' ...
 'R-90 V-90 P-90-0 P-90-1 ' ...
 'R-120 T-120 V-120 P-120-0 R-150 T-150 V-150 P-150-0 ' ...
 'R-152T T-152T V-152T P-152T-1 '];
%sss = ['1 2 3 4 5 6 7 8 9 10 11 12 ' ...
% '13 14 15 16 17 18 19 20 21 22 23 24 ' ...
% '25 26 27 28 29 30 31 32 33 34 35 36 ' ];
sensor = words(sss);

sss2 = ['MP-4.5Hz-geophone MP-4.5Hz-geophone PCB-102A07-15972 PCB-
102A07-15973 ' ...
 'MP-4.5Hz-geophone MP-4.5Hz-geophone PCB-106B50-3260 PCB-106B50-6693 '
...
 'MP-4.5Hz-geophone MP-4.5Hz-geophone PCB-106B50-3259 PCB-106B50-6695 '
...
 'MP-4.5Hz-geophone MP-4.5Hz-geophone MP-4.5Hz-geophone B&K-4939-1 ' ...
 'MP-4.5Hz-geophone MP-4.5Hz-geophone MP-4.5Hz-geophone B&K-4939-2 ' ...
 'MP-4.5Hz-geophone-in-tree MP-4.5Hz-geophone-in-tree ' ...
 'MP-4.5Hz-geophone-in-tree B&K-4939-3-in-tree '];
sensor2 = words(sss2);

% rtype 1 = Microphone, 2 = PCB, 5= Vert, 6 = Horiz, 7 = Accel
rtype = [6 5 2 2 6 5 2 2 6 5 2 2 6 6 5 1 6 6 5 1 6 6 5 1 ];
```

```
% engfact = units per mV
% mV = data_value*descal_fact/stack_count
% phys_units = data_value*descale_fact / (stack_count*engfact)

% Starting nominal values:
engfact = [ ...
 32.2*1000 32.2*1000 100/6895 100/6895 ...
 32.2*1000 32.2*1000 500/6895 500/6895 ...
 32.2*1000 32.2*1000 500/6895 500/6895 ...
 32.2*1000 32.2*1000 32.2*1000 -1.2/1000 ...
 32.2*1000 32.2*1000 32.2*1000 -1.2/1000 ...
 32.2*1000 32.2*1000 32.2*1000 -1.2/1000 ];

if(shotnum >=45);
 engfact(7) = 100/6895; sensor2(7,:)='PCB102A07-15971 ';
end %102A07 15971 from Rec 45 on

% Actual calibrated values:
engfact = [ ...
 32.2*1000 32.2*1000 88.09/6895 85.75/6895 ...
 32.2*1000 32.2*1000 500/6895 464.5/6895 ...
 32.2*1000 32.2*1000 563.2/6895 500/6895 ...
 32.2*1000 32.2*1000 32.2*1000 -1.15/1000 ...
 32.2*1000 32.2*1000 32.2*1000 -1.32/1000 ...
 32.2*1000 32.2*1000 32.2*1000 -1.20/1000 ];

% Adjust for changes in sensor array during test
if(shotnum >=45); engfact(7) = 89.72/6895; end %102A07 15971 from Rec 45
on
if(shotnum >=5 & shotnum <=27); %B&K mikes used for blank pistol shots
 engfact(16) = -0.7501/1000; sensor2(16,:)='B&K-4165-5 ';
 engfact(20) = -0.7436/1000; sensor2(20,:)='B&K-4165-6 ';
end %

% Assign source properties
% Default values
srcloc = 'SP1'; %Nominal value, actual TC locations below
srclocnum = 1; srcx = 0.0; srcy = 0.0; srcz = 1.5;
% stype 1 = C-4, 6 = 50 cal, 9 = 45 cal, 10 = noise
sourcetype = 'C-4'; stype = 1; sourcesize = 1;
```

```
% List of source heights used during tests
sht1 = 0.3048*(6*12+3)/12;
sht2 = 0.3048*(12*12+6)/12;
sht3 = 0.3048*(10*12+0)/12;
sht4 = 0.3048*(4*12+0)/12;
sht5 = 0.3048*(2*12+0)/12;
sht5 = 0.3048*(1*12+0)/12;
srcz = sht1; %default source height = 6 ft 3 = 1.9 m

% Assign C-4 source size
if(shotnum==40 | (shotnum>=96 & shotnum<=113) ) %4 bricks
 sourcesize = 4;
end

% Assign source height
if(shotnum==41 | shotnum==70 | shotnum==109 )
 srcz = sht2; %12-6 feet and inches
end
if(shotnum==42 | shotnum==71 | shotnum==110 )
 srcz = sht2; %10-0
end
if(shotnum==43 | shotnum==72 | shotnum==111 )
 srcz = sht3; %4-0
end
if(shotnum==44 | shotnum==73 | shotnum==112 )
 srcz = sht4; %2-0
end
if(shotnum==60 | shotnum==74 | shotnum==113 )
 srcz = sht5; %1-0
end


% Assign source locations
% TC3 is the origin, 30 m from the first CRREL sensor
if(shotnum==61 | shotnum==65 | shotnum==65 ...
 | shotnum==93 | shotnum==96 | shotnum==100 ...
 | shotnum==104 ) %TC1
 srclocnum=1;srcloc='TC1';srcx=-414.7;source2='Open-field';
end
if(shotnum==60 | shotnum==62 | shotnum==66 ...
 | (shotnum>=70 & shotnum<=74) | shotnum==94 ...
```

```
 | shotnum==97 | shotnum==101 | shotnum==105 ...
 | (shotnum>=108 & shotnum<=113) ) %TC2
 srclocnum=2;srcloc='TC2';srcx=-60.5;source2='Open-field';
end
if((shotnum>=39 & shotnum<=44) | shotnum==63 ...
 | shotnum==67 | shotnum==98 | shotnum==102 ...
 | shotnum==106 ) %TC3
 srclocnum=3;srcloc='TC3';srcx=0.0;source2='Edge-of-forest';
end
if(shotnum==64 | shotnum==68 ...
 | shotnum==95 | shotnum==99 | shotnum==103 ...
 | shotnum==107 ) %TC4
 srclocnum=4;srcloc='TC4';srcx=311.0;source2='Edge-of-forest';
end

if(shotnum==39 | shotnum==69)
 srclocnum=5;srcloc=' ';srcx=0.0;
 sourcetype = 'Noise'; stype = 10; sourcesize = 0;source2='Noise';
end

% Assign source locations for blank pistol shots
if(shotnum<5) %30m
 srclocnum=5;srcloc='30m';srcx=30.0;srcy=2;srcz=1;
 sourcetype = 'Pistol'; stype = 9; sourcesize = 0;source2='In-forest';
end
if(shotnum>=5 & shotnum<10) %90m
 srclocnum=7;srcloc='90m';srcx=90.0;srcy=2;srcz=1;
 sourcetype = 'Pistol'; stype = 9; sourcesize = 0;source2='In-forest';
end
if(shotnum>=10 & shotnum<15) %60m
 srclocnum=6;srcloc='60m';srcx=60.0;srcy=2;srcz=1;
 sourcetype = 'Pistol'; stype = 9; sourcesize = 0;source2='In-forest';
end
if(shotnum>=15 & shotnum<20) %30m
 srclocnum=5;srcloc='30m';srcx=30.0;srcy=2;srcz=1;
 sourcetype = 'Pistol'; stype = 9; sourcesize = 0;source2='In-forest';
end


% Calculate source-to-sensor distances for this shot
srcx2 = srcx*srcx; srcy2 = srcy*srcy; srcz2 = srcz*srcz;
```

```
for i=1:nchan
 dist(i) = ((sensorx(i)-srcx).^2 + ...
 (sensory(i)-srcy).^2 + ...
 (sensorz(i)-srcz).^2 ) .^0.5;
end

return %-----------------------------------------------------------------
```

tx02cerlnum.m—Changes CRREL binary file numbers to CERL shot numbers

```
function [cerlrec ] = tx02cerlnum (shotnum)
% d:\DataWinNT\FY02LoneStarTX\tx02cerlnum.m
% Converts CRREL NZ seismograph file numbers for FY02 TX test
% For C-4, returns CERL Shot Num (1-39, with some "B" repeats)
% For blank pistol, assigns a number in the 100's
% For large Demo shots, assigns a number in the 300's
% Noise records 92-> 401
% Cal record numbers are omitted 20-27, 82-91, 114-199
% Don Albert dalbert@crrel.usace.army.mil
% USA ERDC-CRREL, 72 Lyme Road, Hanover, NH 03755
cerlrec = ' ';
if(shotnum==39);cerlrec = ' 1';end
if(shotnum==40);cerlrec = ' 2';end
if(shotnum==41);cerlrec = ' 3';end
if(shotnum==42);cerlrec = ' 4';end
if(shotnum==43);cerlrec = ' 5';end
if(shotnum==44);cerlrec = ' 6';end
if(shotnum==60);cerlrec = ' 7';end
if(shotnum==61);cerlrec = ' 8';end
if(shotnum==62);cerlrec = ' 9';end
if(shotnum==63);cerlrec = ' 10';end
if(shotnum==64);cerlrec = ' 11';end
if(shotnum==65);cerlrec = ' 12';end
if(shotnum==66);cerlrec = ' 13';end
if(shotnum==67);cerlrec = ' 14';end
if(shotnum==68);cerlrec = ' 15';end
% The next shots are repeats of Shots 3-7
% We assign the CERL numbers 43-47
if(shotnum==70);cerlrec = ' 43';end
if(shotnum==71);cerlrec = ' 44';end
```

```
if(shotnum==72);cerlrec = ' 45';end
if(shotnum==73);cerlrec = ' 46';end
if(shotnum==74);cerlrec = ' 47';end
if(shotnum==93);cerlrec = ' 16';end
if(shotnum==94);cerlrec = ' 17';end
if(shotnum==95);cerlrec = ' 19';end
% missed CERL shot 18
if(shotnum==96);cerlrec = ' 20';end
if(shotnum==97);cerlrec = ' 21';end
if(shotnum==98);cerlrec = ' 22';end
if(shotnum==99);cerlrec = ' 23';end
if(shotnum==100);cerlrec = ' 24';end
if(shotnum==101);cerlrec = ' 25';end
if(shotnum==102);cerlrec = ' 26';end
if(shotnum==103);cerlrec = ' 27';end
if(shotnum==104);cerlrec = ' 28';end
if(shotnum==105);cerlrec = ' 29';end
if(shotnum==106);cerlrec = ' 30';end
if(shotnum==107);cerlrec = ' 31';end
if(shotnum==108);cerlrec = ' 32';end
if(shotnum==109);cerlrec = ' 33';end
if(shotnum==110);cerlrec = ' 34';end
if(shotnum==111);cerlrec = ' 35';end
if(shotnum==112);cerlrec = ' 36';end
if(shotnum==113);cerlrec = ' 37';end
% CRREL Blank Pistol Shots
if(shotnum== 1);cerlrec = '101';end
if(shotnum== 2);cerlrec = '102';end
if(shotnum== 3);cerlrec = '103';end
if(shotnum== 4);cerlrec = '104';end
if(shotnum== 5);cerlrec = '105';end
if(shotnum== 6);cerlrec = '106';end
if(shotnum== 7);cerlrec = '107';end
if(shotnum== 8);cerlrec = '108';end
if(shotnum== 9);cerlrec = '109';end
if(shotnum==10);cerlrec = '110';end
if(shotnum==11);cerlrec = '111';end
if(shotnum==12);cerlrec = '112';end
if(shotnum==13);cerlrec = '113';end
if(shotnum==14);cerlrec = '114';end
if(shotnum==15);cerlrec = '115';end
```

```
if(shotnum==16);cerlrec = '116';end
if(shotnum==17);cerlrec = '117';end
if(shotnum==18);cerlrec = '118';end
if(shotnum==19);cerlrec = '119';end
% Large in-ground Demolition Shots
if(shotnum==28);cerlrec = '301';end
if(shotnum==29);cerlrec = '302';end
if(shotnum==30);cerlrec = '303';end
if(shotnum==31);cerlrec = '304';end
if(shotnum==32);cerlrec = '305';end
if(shotnum==33);cerlrec = '306';end
if(shotnum==34);cerlrec = '307';end
if(shotnum==35);cerlrec = '308';end
if(shotnum==36);cerlrec = '309';end
if(shotnum==37);cerlrec = '310';end
if(shotnum==38);cerlrec = '311';end
if(shotnum==45);cerlrec = '312';end
if(shotnum==46);cerlrec = '313';end
if(shotnum==47);cerlrec = '314';end
if(shotnum==48);cerlrec = '315';end
if(shotnum==49);cerlrec = '316';end
if(shotnum==50);cerlrec = '317';end
if(shotnum==51);cerlrec = '318';end
if(shotnum==52);cerlrec = '319';end
if(shotnum==53);cerlrec = '320';end
if(shotnum==54);cerlrec = '321';end
if(shotnum==55);cerlrec = '322';end
if(shotnum==56);cerlrec = '323';end
if(shotnum==57);cerlrec = '324';end
if(shotnum==58);cerlrec = '325';end
if(shotnum==59);cerlrec = '326';end
if(shotnum==75);cerlrec = '327';end
if(shotnum==76);cerlrec = '328';end
if(shotnum==77);cerlrec = '329';end
if(shotnum==78);cerlrec = '330';end
if(shotnum==79);cerlrec = '331';end
if(shotnum==80);cerlrec = '332';end
if(shotnum==81);cerlrec = '333';end
% Misfire = Noise record
if(shotnum==92);cerlrec = '401';end
return
```

tx02plotnz.m—Three-panel plot of binary seismograph data

```
function
tx02plotnz(shotnum,cerlrec,xx,iplot1,iplot2,iplot3,deltat,delayms,...
 dist,sensor,sensorx,sensory,sensorz,...
 srcloc,sourcesize,sourcetype,srcx,srcy,srcz);

% d:\DataWinNT\FY02LoneStarTX\Plot\tx02plotnz.m
%
% Plots nchan channels of data for Texas 02 NZ data
% Data are in array xx
% Channels to plot in each panel are in iplot1,2,3
% Does not call any subroutines
%
% Because of CRREL blaster box problems, there are no good time
% breaks in the data, and long record lengths were used. The
% data are aligned before plotting based on the actual arrival
% times found in the recorded data.

% Don Albert dalbert@crrel.usace.army.mil
% USA ERDC-CRREL, 72 Lyme Road, Hanover, NH 03755

nplot1 = length(iplot1);nplot2 = length(iplot2);
nplot3 = length(iplot3);
xxmax = max(abs(xx)); %abs max for plotting

srate = 1/ deltat; %number of samples per second


% Determine the time window and direction of arrivals for the shots
% Time windows for C-4 shots
[aa bb] = max(xx); %set plot windows because manual TB
[cc dd] = min(xx); %for output file
tmax4 = delayms/1000 + (bb(4) )/srate; %times in seconds
tmax20 = delayms/1000 + (bb(20))/srate;
tmax16 = delayms/1000 + (bb(16))/srate;
tmax12 = delayms/1000 + (bb(12))/srate;
tstart4= floor(tmax4 *10)/10;
tstart20= round(tmax20*10)/10;
tstart16= floor(tmax16*10)/10;
if(tstart4 < tstart16)
```

```
 tstartpanel1 = tstart4;tendpanel1 = tstartpanel1 + 0.5;
 tstartpanel2 = tstart16;tendpanel2 = tstartpanel2 + 0.5;
 tstartpanel3 = tstartpanel1;tendpanel3 = tstart20 + 0.1;
else %if(tstart16 < tstart4)
tstart4= round(tmax4 *10)/10;
tstart12= floor(tmax12*10)/10;
tstart20= floor(tmax20*10)/10;
tstart16= round(tmax16*10)/10;
 tstartpanel1 = tstart12;tendpanel1 = tstartpanel1 + 0.5;
 tstartpanel2 = tstart20;tendpanel2 = tstartpanel2 + 0.5;
 tstartpanel3 = tstartpanel2;tendpanel3 = tstart4 + 0.1;
end

% Time windows for blank pistol shots
if(shotnum<5) %Pistol shots at 30 m, use mike at 90 m = Chan 12
 tstart12= floor(tmax12*10)/10;
 tstartpanel1 = tstart12-0.2;tendpanel1 = tstartpanel1 + 0.6;
 tstartpanel2 = tstart12-0.2;tendpanel2 = tstartpanel2 + 0.6;
 tstartpanel3 = tstartpanel1;tendpanel3 = tendpanel1;
end
if(shotnum>4 & shotnum<20) %Pistol shots at 90 m, use mike at 90 m =
Chan 12
 tstart12= floor(tmax12*10)/10;
 tstartpanel1 = tstart12-0.1;tendpanel1 = tstartpanel1 + 0.6;
 tstartpanel2 = tstart12-0.1;tendpanel2 = tstartpanel2 + 0.6;
 tstartpanel3 = tstartpanel1;tendpanel3 = tendpanel1;
end

% time series
tend = length(xx(:,1)); %all data
t = delayms/1000 + (1:tend)/srate;

% Start of data plot %***************************************
nametext = ['NZ Data - 3 panel']; %---------FIGURE - 3 Panels
f1 = figure('Name',nametext);
set(gcf,'Units','inches','PaperUnits','inches');

subplot(1,3,1); %Left (1st) panel of plot ------------------
iplot=iplot1; nplot=nplot1;
%iplot=1:12; %Channels 1-12 %iplot=12:-1:1; %Channels 1-12
```

```
% Set axis params here; depends on nplot - t2
yshift = (1:nplot)*2 - 2;
ax = [tstartpanel1-0.05 tendpanel1 -1 2*nplot];
axis(ax);
ax1 = gca; set(ax1,'YTick',[]); set(ax1,'Box','on');
xlabel('Time, sec')

% plot data and label
hold on;
for i=1:nplot
 plot(t,(xx(1:length(t),iplot(i))/xxmax(iplot(i))) +yshift(i),'k');
 leftlabel = sprintf('%g',round(dist(iplot(i))));
 % Text labels for plot
 str1 = sensor(iplot(i),:);
 str2 = sprintf('%7.2e',(xxmax(iplot(i))));
 if (xxmax(iplot(i))) < 0.0001
 str2=sprintf('%4.1fE-6',(1E6*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.001
 str2=sprintf('%4.2fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.1
 str2=sprintf('%4.1fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 10.0
 str2=sprintf('%4.2f',(xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) > 1000.0
 str2=sprintf('%4.1fk',( xxmax(iplot(i))/1000 ));
 else
 str2=sprintf('%4.1f',(xxmax(iplot(i))));
 end %text loop
 str3 = char(str1);
 str4 = char(str3 , str2);
 str5 = cellstr(str4);
 text(tendpanel1+0.02,[yshift(i)],str5,'FontSize',8,...
 'HorizontalAlignment','left');
end %plot loop i=1:nplot

subplot(1,3,2); %Center (2nd) panel of plot -----------------------
iplot=iplot2; nplot=nplot2;
yshift = (1:nplot)*2 - 2;
ax = [tstartpanel2-0.05 tendpanel2 -1 2*nplot];
axis(ax);
ax1 = gca; set(ax1,'YTick',[]); set(ax1,'Box','on');
```

```
xlabel('Time, sec')

% plot data and label
hold on;
for i=1:nplot
 plot(t,(xx(1:length(t),iplot(i))/xxmax(iplot(i))) +yshift(i),'k');
 leftlabel = sprintf('%g',round(dist(iplot(i))));
% Text labels for plot
 str1 = sensor(iplot(i),:);
 str2 = sprintf('%7.2e',(xxmax(iplot(i))));
 if (xxmax(iplot(i))) < 0.0001
 str2=sprintf('%4.1fE-6',(1E6*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.001
 str2=sprintf('%4.2fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.1
 str2=sprintf('%4.1fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 10.0
 str2=sprintf('%4.2f',(xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) > 1000.0
 str2=sprintf('%4.1fk',( xxmax(iplot(i))/1000 ));
 else
 str2=sprintf('%4.1f',(xxmax(iplot(i))));
 end %text loop
 str3 = char(str1);
 str4 = char(str3 , str2);
 str5 = cellstr(str4);
 text(tendpanel2+0.02,[yshift(i)],str5,'FontSize',8,...
 'HorizontalAlignment','left');
end %plot loop i=1:nplot


subplot(1,3,3); %Right (3rd) panel of plot ------------------------
% Pressure sensors only
iplot=iplot3; nplot=nplot3;
yshift = (1:nplot)*2 - 2;
ax = [tstartpanel3-0.05 tendpanel3 -1 2*nplot];
axis(ax);
ax1 = gca; set(ax1,'YTick',[]); set(ax1,'Box','on');
xlabel('Time, sec')

% plot data and label
```

```
hold on;
for i=1:nplot
 if(xxmax(iplot(i)==0));xxmax(iplot(i))=1;end
 plot(t,(xx(1:length(t),iplot(i))/xxmax(iplot(i))) +yshift(i),'k');
 leftlabel = sprintf('%g',round(dist(iplot(i))));
 % Text labels for plot
 str1 = sensor(iplot(i),:);
 str2 = sprintf('%7.2e',(xxmax(iplot(i))));
 if (xxmax(iplot(i))) < 0.0001
 str2=sprintf('%4.1fE-6',(1E6*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.001
 str2=sprintf('%4.2fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.1
 str2=sprintf('%4.1fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 10.0
 str2=sprintf('%4.2f',(xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) > 1000.0
 str2=sprintf('%4.1fk',( xxmax(iplot(i))/1000 ));
 else
 str2=sprintf('%4.1f',(xxmax(iplot(i))));
 end %text loop
 str3 = char(str1);
 str4 = char(str3 , str2);
 str5 = cellstr(str4);
 text(tendpanel3+0.02,[yshift(i)],str5,'FontSize',8,...
 'HorizontalAlignment','left');
 % Write title for right panel
 if(i==nplot)
 text(tstartpanel3+0.05,yshift(i)+1,'Pressure Sensors');
 end

end %plot loop i=1:nplot
************************************************

% Title for entire plot --------------------------------------------------
----------
if(sourcesize~=0) %C-4 shot
 plottitle = ...
 sprintf('TX02 -- Shot %s Rec %g -- %s %3.1f kg %s %3.1f m agl -- %3.0f-
%3.0f m',...
```

```
cerlrec,shotnum,srcloc,sourcesize*1.25/2.2,sourcetype,srcz,min(dist),max
(dist));
else %not C-4 shot
 plottitle = ...
 sprintf('TX02 -- Record %g -- %s %s %3.1f m -- %3.0f-%3.0f m',...
 shotnum,srcloc,sourcetype,srcz,min(dist),max(dist));
end

ax=axes('Units','Normal','Position',[0.075 0.075 0.85 0.85],...
 'Visible','of');
set(get(ax,'Title'),'Visible','on');
title(plottitle,'FontSize',18,'FontWeight','Bold');

set(gcf,'PaperUnits','inches');
set(gcf,'PaperPosition',[0.5,0.25,10,7]);
set(gcf,'PaperOrientation','landscape');

return
```

tx02tbcorr—Finds true shot instant

```
function [itimeTB,itime0,itime1,time0,xdist,xtime] =
tx02tbcorr(shotnum,...
 cerlrec,xx,deltat,delayms,srcloc)

% d:\DataWinNT\FY02LoneStarTX\Plot\tx02tbcorr.m
% Finds TB (time break or shot instant) from data
% This is done by finding the slope of the travel time
% curve for the first and last pressure sensor in the
% array to find the acoustic velocity. This velocity
% is then used to find the shot time.
% The data are shifted so that time=0 is the
% actual shot time.
% Writes info to Timebreaklogtx02.m
% Does not call any other subroutines

% itimeTB is the TB (shot instant) index
% itime0 is the index to start the save (usually=TB)
% if the shot was at TC1, 1 second is added to itime0
% itime1 is the index 2 seconds after the TB
```

```
% time0 is the start time for saving the time series

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fid13=fopen('Tx02TimeBreakLog.m','a');

srate = 1/ deltat;% number of samples per second

% Pressure channels to process
[a b] = max(xx(:,[4 8 12 16 20]));
b2 = b + delayms*srate/1000; b2 = b2/srate;


xp = [ 30 60 90 120 150];
if (srcloc(3)=='1');
 xp = xp + 445 - 30; %TC1
elseif(srcloc(3)=='2')
 xp = xp + 91 - 30; %TC2
elseif(srcloc(3)=='3')
 xp = xp + 0; %TC3
elseif(srcloc(3)=='4')
 xp = [281 251 221 191 161]; %TC4
else
 xp = [ 30 60 90 120 150];
end

vel = (xp(5)-xp(1)) / (b2(5) - b2(1));
t1actual = xp(1)/vel;
t0corr = t1actual - b2(1);
b3 = b2 + t0corr; %Corrected travel times

% Code for pistol shots only - uses different sensors
if(shotnum <= 19); %Blank pistol shots
 if(shotnum <=4) %pistol at 30 m
 iii1 = 1; iii2 = 3; %start chan 4, end chan 12
 elseif(shotnum>4 & shotnum<9) %pistol at 90 m
 iii1 = 3; iii2 = 5; %start chan 12, end chan 20
 elseif(shotnum>9 & shotnum<14) %pistol at 60 m
 iii1 = 2; iii2 = 4; %start chan 8, end chan 16
```

```
 elseif(shotnum>14 ) %pistol at 30 m
 iii1 = 1; iii2 = 3; %start chan 4, end chan 12
 end
 vel = (xp(iii2)-xp(iii1)) / (b2(iii2) - b2(iii1));
 t1actual = 2/vel; %Pistol shot was 2 m from nearest sensor
 t0corr = t1actual - b2(iii1);
 b3 = b2 + t0corr; %Corrected travel times
 fprintf(fid13,...
 'Shot %g %s Blank pistol Velocity = %6.1f m/s TB corr = %6.4f \n',...
 shotnum,srcloc,vel,t0corr);
else %C-4 shot
 fprintf(fid13,... %C-4 shot print statement
 'Shot %g %s CERL %s Velocity = %6.1f m/s TB corr = %6.4f \n',...
 shotnum,srcloc,cerlrec,vel,t0corr);
end %code for pistol shots

itimeTB = -floor((t0corr + delayms/1000) * srate);
itime0 = -(t0corr + delayms/1000) * srate;
itime0 = floor(itime0);
time0 = 0.0;% Start ascii data at 0.0 sec (shot instant)
% For TC1, start ascii data at 1.0 sec
if(srcloc == 'TC1');
 itime0 = itime0 + 1.0 *srate;
 time0 = 1.0;
end

if(shotnum==39 | shotnum==44); %Bad records, missed shot
 t0corr = 0; %Use original zero time
 itimeTB = -floor((t0corr + delayms/1000) * srate);
 itime0 = -(t0corr + delayms/1000) * srate;
 itime0 = floor(itime0);
 time0 = 0.0;% Start ascii data at 0.0 sec (shot instant)
end

itime1 = itime0 + 2*srate;% Write 2 seconds of ascii data

xdist = xp;
xtime = b3;


fclose(fid13);
```

```
return
```

tx02writenchan.m – Writes multichannel ASCII file tx02nnn.asc

```
function tx02writenchan(shotnum,cerlrec,xx,npts,deltat,nchan,delayms,…
 descalingfact,...
 stackcount,acqdate,acqtime,engfact,xgain,itime0,itime1,time0,...
 dist,sensor,rtype,sensorx,sensory,sensorz,sensor2,...
 srcloc,stype,sourcetype,sourcesize,srcx,srcy,srcz,source2);

% d:\DataWinNT\FY02LoneStarTX\Plot\tx02writenchan.m
% Writes nchan (24) channel ascii file for Texas 2002 data
% File name is tx02xxx.asc, where xxx is a new file number
% xxx = CERL Shot number if it was a C-4 shot
% Calls no subroutines

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srate = 1/ deltat; % number of samples per second
recnum = shotnum; npts = length(xx);
stype = 1; signal=1; srccomment=source2;
if(shotnum<20); stype = 5; signal = 0; end
 comment = 'Lone Star AAP, Texarkana, TX Blast Noise Through Forest
w/CERL';

% Construct ascii file name and open
cerlrec2 = str2num(cerlrec)+2000;
if(cerlrec~=0);
 fname2 = sprintf('tx0%g.asc',cerlrec2); %tx02001 - tx02037
else
 if(recnum<10)
 fname2 = sprintf('tx02spistol0%s.asc',num2str(recnum)); %tx02pistol01 -
09
 else
 fname2 = sprintf('tx02pistol%s.asc',num2str(recnum)); %tx02pistol10 -
19
 end
end
fid5=fopen(fname2,'w');
```

```
% (itime0:itime1) time0 = start time in sec

% File header - Same for all records in this expt:
projectnum = 200202; project = 'TX02';
itbtype = 1; tbtype='Manual';% manual;
itbcorr = 1; %TB corrected? 1=Yes
npts2 = 16000; %Npts to write to ascii file

% File header - for all channels in this record or shot
tbcorr = itime0; %Find TB correction from data - from tbcorr2
starttimes = time0; %Start time in sec, for TC1 - from tbcorr2
%stype = 1; signal=1;srccomment='In Open Field';

% Write each channel
[aa bb] = max(xx); %set plot windows because manual TB
[cc dd] = min(xx); %set plot windows because manual TB
%for iii =1:nplot;

% Loop over sensors ********************************************
for iii = 1:nchan %
% File header - for this channel only
 ichan = iii; irtype = 2; reccomment = sensor2(ichan,:);
 tmax = delayms/1000 + (bb(iii) )/srate; %times in seconds
 tmin = delayms/1000 + (dd(iii) )/srate; %times in seconds
 xxmax = aa(iii); xxmin = cc(iii);

% Write header
 fprintf(fid5,...
 'Project no Filename Recno Cerlrecno Date Time \n');
 fprintf(fid5, '%g %s %s %g %s %s %s \n',...
 projectnum,project,fname2,recnum,cerlrec,acqdate,acqtime);

 fprintf(fid5, 'TBtype Corrected? Delayms OrigNpts TBtype \n');
 fprintf(fid5,...
 '%g %g %g %g %s \n',...
 itbtype,itbcorr,delayms,npts,tbtype);

 fprintf(fid5, 'Nchan Npts2 Srate TBcorr Starttime(s) \n');
 fprintf(fid5, ' %g %g %g %g %7.4f \n',...
 nchan,npts2,srate,tbcorr,starttimes);
```

```
 fprintf(fid5, 'Stype Signal? Src (x,y,z) Size \n');
 fprintf(fid5,...
 ' %g %g %7.2f %7.2f %7.2f %g %s %s %s \n',...
 stype,signal,srcx,srcy,srcz,sourcesize,srcloc,...
 sourcetype,srccomment);

 fprintf(fid5,'Ichan Rtype Rec (x,y,z) \n');
 fprintf(fid5,...
 ' %g %g %7.2f %7.2f %7.2f %s %s \n',...
 ichan,rtype(ichan),sensorx(ichan),sensory(ichan),...
 sensorz(ichan),sensor(ichan,:),reccomment);

 fprintf(fid5,...
 'Dist(m) Engfact,Xgain,Stack Pmax, T Pmin, T(s) \n');
 fprintf(fid5,...
 '%7.1f %14.6e %14.6e %g %11.3e %7.4f %11.3e %7.4f \n',...
 dist(ichan),engfact(ichan),xgain(ichan),...
 stackcount(ichan),xxmax,tmax,xxmin,tmin);

 fprintf(fid5,'%s \n',comment);

% Write data
% x is raw data (mV), xx is data in physical units.
 fprintf(fid5,...
 '%15.7e %15.7e %15.7e %15.7e %15.7e \n', ...
 xx(itime0:itime1,ichan));
 nwrite = (itime0+itime1+1)/5; nwriteint = floor(nwrite);
 if(nwrite-nwriteint~=0); fprintf(fid5,'\n');end

end % loop over sensors ************************

fclose(fid5);
return %------------------------------------------------------
```

readnz.m—Reads NZ seismograph binary data file

```
function [scan,samplesPerScan,samplingInterval,nbOfTraces, ...
 delaytime,descalingfact,stackcount,acqdate,acqtime] = readnz (filename)

% Reads a binary seismograph file in SEG-2 format, and returns the
```

```
% data in "scan" variable above.
% This code written by Don Albert, CRREL, and based on code "SEG2LOAD"
written
% by Pièce PY to read a radar file in modified SEG-2 format. Some of
Piece's
% original code is still here in this file.
% Calls subroutine words.m
% Writes info about the file to file readnzlog.m

% To read one NZ file directly:
% fname = '10077.dat';
% [x,npts,deltat,nchan,npts2,delayms,descalingfact,acqdate,…
% acqtime] = readnz(fname);

% READNZ - For Geometrics NZ seismograph
%This version modified from MOUT data for MN02 data

% READNZ Modified by D Albert to read standard SEG-2 format
% SEG2LOAD Read a SEG-2 (standard SEG-2 format of the Society of
% Exploration Geophysicist) file from disk.
% [scan,samplesPerScan,samplingInterval,shaftInterval,
% timerFrequency] =seg2load ('filename') reads the file 'filename'
% and returns the image scan [m,n] containing n A-Scan of m samples.
% If no extension is given for the filename, the extension
% '.sg2' is assumed.
% samplesPerScan contains the number of samples per A-scan
% shaftInterval contains the distance between shaft encoder
% triggers in meter
% samplingInterval contains the time between 2 samples in pico-seconds
% timerFrequency contains the frequency of A-scan sampling in Hz
%
% Pièce PY 24/07/1996
% LAMI - DeTeC Demining Technology Center
% Swiss Federal Institute of Technology (EPFL) –
% Lausanne, Switzerland

% Don Albert dalbert@crrel.usace.army.mil
% USA ERDC-CRREL, 72 Lyme Road, Hanover, NH 03755

% check argument and filename
 if (nargin==0)
```

```
 error ('readseg2 requires at least a filename as an argument !');
 end;
 if (isstr (filename)~=1)
 error ('Argument is not a filename !');
 end;
 if (isempty (findstr (filename,'.'))==1)
 filename =[filename,'.sg2'];
 end;
 fid=fopen (filename,'rb','ieee-le');
 if (fid ==-1)
 error (['Error opening ',filename,' for input !']);
 end;

% check for SEG-2 file type
% first 2 bytes equal '3a55h' (14933) for PC/Windows
 fileType=fread (fid,1,'short');
 if (fileType ~= 14933)
 fclose (fid);
 error ('Not a SEG-2 file !');
 end;

 % Open a log file to keep track of files that were read
 fid2 = fopen('readnzlog.m','a');
 % fprintf(fid2,' \n');

 samplesPerScan =0;
 shaftInterval =0;
 samplingInterval=0;
 timerFrequency =0;

% read File Descriptor Block

 revNumber = fread (fid,1,'short');
 sizeOfTracePointer = fread (fid,1,'ushort');
 nbOfTraces = fread (fid,1,'ushort');
 sizeOfST = fread (fid,1,'uchar');
 firstST = fread (fid,1,'char');
 secondST = fread (fid,1,'char');
 sizeOfLT = fread (fid,1,'uchar');
 firstLT = fread (fid,1,'char');
 secondLT = fread (fid,1,'char');
```

```
 reserved = fread (fid,18,'uchar');
 tracePointers = fread (fid,nbOfTraces,'ulong');

% read free strings

 fseek (fid,32+sizeOfTracePointer,'bof');
 offset = fread (fid,1,'ushort');

% File descriptor block
 while (offset > 0)
 freeString = setstr (fread (fid,offset-2,'char'))'; %
 %Decode file descriptor block
 if (findstr (freeString,'ACQUISITION_DATE') > 0)
 acqdate = (freeString ...
 (length ('ACQUISITION_DATE '):length (freeString)));
 end
 if (findstr (freeString,'ACQUISITION_TIME') > 0)
 acqtime = (freeString ...
 (length ('ACQUISITION_TIME '):length (freeString)));
 end
 offset = fread (fid,1,'ushort');
 end;

% read traces

%find number of samples per trace
% First trace descriptor block
 fseek (fid,tracePointers (1),'bof');
 traceId = fread (fid,1,'ushort');
 sizeOfBlock = fread (fid,1,'ushort');
 sizeOfData = fread (fid,1,'ulong');
 nbOfSamples = fread (fid,1,'ulong');
 samplesPerScan = nbOfSamples;

 dataCode = fread (fid,1,'uchar');
 reserved = fread (fid,19,'uchar');
 offset = fread (fid,1,'ushort');
 while (offset > 0)
 freeString = setstr (fread (fid,offset-2,'char'))';
 if (findstr (freeString,'SAMPLE_INTERVAL') > 0)
 samplingInterval = str2num (freeString ...
```

```
(length ('SAMPLE_INTERVAL '):length (freeString)));
end
if (findstr (freeString,'DELAY') > 0)
delaytime = 1000*str2num (freeString ...
(length ('DELAY '):length (freeString)));
end
if (findstr (freeString,'DESCALING_FACTOR') > 0)
descalingfactor = str2num (freeString ...
(length ('DESCALING_FACTOR '):length (freeString)));
end
offset = fread (fid,1,'ushort');
end;

%Write file descriptor to log file
fprintf(fid2,'%s %s %s %g %g %g %g \n',...
filename,acqdate,acqtime,nbOfSamples,...
samplingInterval,delaytime,descalingfactor);

scan = zeros (nbOfSamples,nbOfTraces);
for i=1:nbOfTraces,
fseek (fid,tracePointers (i),'bof');
traceId = fread (fid,1,'ushort');
sizeOfBlock = fread (fid,1,'ushort');
sizeOfData = fread (fid,1,'ulong');
nbOfSamples = fread (fid,1,'ulong');
dataCode = fread (fid,1,'uchar');
reserved = fread (fid,19,'uchar');
% Trace descriptor blocks
%Reads all at once
freeString = setstr (fread (fid,sizeOfBlock-32,'char'))';

w = words(freeString);
%MOUT data
%descalingfact(i) = str2num(w(4,1:14));
%stackcount(i) = str2num(w(18,1:2));
%[aasizew bbsizew] = size(w);
%if(aasizew==30);
% stackcount(i) = str2num(w(27,1:2));
%else
% stackcount(i) = str2num(w(26,1:2));
% end
```

```
 %stackcount(i) = str2num(w(26,1:2));
 descalingfact(i) = str2num(w(7,1:14));
 stackcount(i) = 1;

 % read the data here
 scan (1:nbOfSamples,i) = fread (fid,nbOfSamples,'float32');
 end;

 fclose (fid); %close data file

 return
```

words.m—Separates string into individual words

```
function all_words = words(input_string)
% filename: words.m
% Separates words in a long string
% Individual words are then in all_words(9,:)
% From the book, Using Matlab, p. 11-12

remainder = input_string;
all_words = '';

while (any(remainder))
 [chopped,remainder] = strtok(remainder);
 all_words = strvcat(all_words,chopped);
end

return
```

APPENDIX C: MATLAB PROGRAMS TO READ AND PLOT MULTICHANNEL ASCII DATA FILES.

This section provides a listing of the MATLAB programs used to read and plot the 24 channel ASCII data files that were constructed from the binary files using the programs in the previous section. The files that are listed in this section are:

9. **doplotasc.m** – Main program to read multichannel ASCII file and make a three-panel plot of the data. To use, set the desired ASCII file numbers in the variable "recs" and run the program. You may have to change the lines that construct the filenames to use the correct directory for your computer, and you may want to change the print options at the very end of this program to match your printer or delete the plot from the screen after plotting. Calls the programs listed below.
10. **readascii.m** – Function to read in the data from the multichannel ASCII files. Calls function words.m
11. **plotasc.m** – Function to make a three-panel plot of the data in landscape orientation. The channels plotted in each of the panels are given by the contents of iplot1, iplot2, and iplot3.
12. **words.m** – Function to parse a string into individual words. This function is listed in the previous section.

doplotasc.m—Reads and plots multichannel ascii files

```
% d:\DataWinNT\FY02LoneStarTX\Plot\doplotasc.m
% Reads multichannel ascii file, makes 3 panel plots of data
% Calls functions
% readascii.m - to read the multichannel ascii data
% words.m - to parse ascii header lines
% plotasc.m - make a 3 panel plot of the data

% Ascii record numbers;
% All C-4 (1,5,6,10,18 bad) and all blank pistol
% recs = [11 12 13 14 103 105 110 115 ]; %Example files
recs = [ 2:4 7:9 11:17 19:37 43:48 101:119];

% Loop to read and plot the files
for i = 1:length(recs);
 recnum = recs(i);
 shotnum = recs(i);
```

```
 recnum = recnum+2000;
 fname = sprintf('tx0%g.asc',recnum); %tx02001 - tx02037
% Read in the data from the ascii multichannel file
 [projectnum,project,fname2,recnum,cerlrec,acqdate,acqtime,...
 itbtype,itbcorr,delayms,npts,tbtype,...
 nchan,npts2,srate,deltat,tbcorr,starttime,...
 stype,signal,srcx,srcy,srcz,sourcesize,srcloc,sourcetype,srccomment,...
 rtype,sensorx,sensory,sensorz,sensor,sensor2,...
 dist,engfact,xgain,stackcount,xxmax,tmax,xxmin,tmin,xx]= ...
 readascii(recnum,fname);

% 3 panel plot of ascii data
% Assign the channels to each panel of the plot
 iplot1 = [9 10 11 12 5 6 7 8 1 2 3 4]; %Channels for 1st (left) panel
 iplot2 = [22 21 23 24 18 17 19 20 14 13 15 16 ]; % 2nd (center) panel
 iplot3 = [24 20 16 11 12 7 8 3 4]; %Channels for 3rd (right) panel
% Make the plot
 plotasc(shotnum,fname,xx,iplot1,iplot2,iplot3,deltat,starttime,...
 dist,sensor,sensorx,sensory,sensorz,...
 srcloc,sourcesize,sourcetype,srcx,srcy,srcz);

% Print and delete
% print -dljetplus;
 print -dljetplus; pause(10); h=gcf; delete(h);
% print to PostScript file for conversion to PDF:
% print -dps -r150 -append tx02datafigs
% h=gcf;delete(h);

end

return %-------------------------------------------------
```

readascii.m—Reads in data from multichannel ASCII file

```
function [projectnum,project,fname2,recnum,cerlrec,acqdate,acqtime,...
 itbtype,itbcorr,delayms,npts,tbtype,...
 nchan,npts2,srate,deltat,tbcorr,starttime,...
stype,signal,srcx,srcy,srcz,sourcesize,srcloc,sourcetype,srccomment,...
 rtype,sensorx,sensory,sensorz,sensor,sensor2,...
 dist,engfact,xgain,stackcount,xxmax,tmax,xxmin,tmin,xx]= ...
 readascii(recnum,fname);
```

```
% d:\DataWinNT\FY02LoneStarTX\Plot\readascii.m
% Reads in ascii seismograph data from fid6
% Calls words.m - parse string into individual words

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% USA ERDC-CRREL, 72 Lyme Road, Hanover, NH 03755

% Read first header to get number of channels
fid6=fopen(fname,'r');
line1 = fgets(fid6);%Project no Filename Recno Cerlrecno Date Time
line2 = fgets(fid6);
line3 = fgets(fid6);%TBtype Corrected? Delayms OrigNpts TBtype
line4 = fgets(fid6);
line5 = fgets(fid6);%Nchan Npts2 Srate TBcorr Starttime(s)
line6 = fgets(fid6);
line7 = fgets(fid6);%Stype Signal? Src (x,y,z) Size
line8 = fgets(fid6);
line9 = fgets(fid6);%Ichan Rtype Rec (x,y,z)
line10 = fgets(fid6);
line11 = fgets(fid6);%Dist(m) Engfact,Xgain,Stack Pmax, T Pmin, T(s)
line12 = fgets(fid6);
line13 = fgets(fid6);%Comment
a6 = words(line6);
nchan = str2num(a6(1,:)); npts2 = str2num(a6(2,:));

fid6=fopen(fname,'r'); %rewind file

for iii = 1:nchan % Read data *******************

% Read header - Same for all records in this expt:
line1 = fgets(fid6); line2 = fgets(fid6); line3 = fgets(fid6);
line4 = fgets(fid6); line5 = fgets(fid6); line6 = fgets(fid6);
line7 = fgets(fid6); line8 = fgets(fid6); line9 = fgets(fid6);
line10 = fgets(fid6); line11 = fgets(fid6); line12 = fgets(fid6);
line13 = fgets(fid6); %Comment

% decode header
a2 = words(line2); a4 = words(line4); a6 = words(line6);
a8 = words(line8); a10 = words(line10); a12 = words(line12);
```

```
%projectnum,project,fname2,recnum,cerlrec,acqdate,acqtime
projectnum = a2(1,:); project = a2(2,:); fname2 = a2(3,:);
recnum = str2num(a2(4,:)); cerlrec = str2num(a2(5,:));
acqdate = a2(6,:); acqtime = a2(7,:);
shotnum = recnum;

%itbtype,itbcorr,delayms,npts,tbtype
itbtype = str2num(a4(1,:)); itbcorr = str2num(a4(2,:));
delayms = str2num(a4(3,:));
npts = str2num(a4(4,:)); tbtype = a4(5,:);

%nchan,npts2,srate,tbcorr,starttimes
nchan = str2num(a6(1,:)); npts2 = str2num(a6(2,:));
srate = str2num(a6(3,:));
tbcorr = str2num(a6(4,:)); starttime = str2num(a6(5,:));
deltat = 1/srate;

%stype,signal,srcx,srcy,srcz,sourcesize,srcloc,
% sourcetype,srccomment
stype = str2num(a8(1,:)); signal = str2num(a8(2,:));
srcx = str2num(a8(3,:));
srcy = str2num(a8(4,:)); srcz = str2num(a8(5,:));
sourcesize = str2num(a8(6,:));
srcloc = a8(7,:); srcloc = words(srcloc);
sourcetype = a8(8,:); sourcetype = words(sourcetype);
srccomment = a8(9,:);

%ichan,rtype(ichan),sensorx(ichan),sensory(ichan),
% sensorz(ichan),sensor(ichan,:),reccomment
ichan = str2num(a10(1,:)) ;
rtype(ichan) = str2num(a10(2,:));
sensorx(ichan) = str2num(a10(3,:));
sensory(ichan) = str2num(a10(4,:));
sensorz(ichan) = str2num(a10(5,:));
sensor(ichan,1:length(a10)) = a10(6,1:length(a10));
reccomment = a10(7,:);
sensor2(ichan,1:length(a10)) = a10(7,1:length(a10));

%dist(ichan),engfact(ichan),xgain(ichan),stackcount(ichan),
% xxmax,tmax,xxmin,tmin
dist(ichan) = str2num(a12(1,:));
```

```
engfact(ichan) = str2num(a12(2,:));
xgain(ichan) = str2num(a12(3,:));
stackcount(ichan) = str2num(a12(4,:));
xxmax(ichan) = str2num(a12(5,:)); tmax(ichan) = str2num(a12(6,:));
xxmin(ichan) = str2num(a12(7,:)); tmin(ichan) = str2num(a12(8,:));

% Put data in xx
data = [];
data = [data; fscanf(fid6, '%g')];
xx(:,ichan) = data;

end % loop iii = 1:nchan % Read data *******************

fclose(fid6);
return %-----------------------
```

plotasc.m—Three-panel plot

```
function
plotasc(shotnum,fname,xx,iplot1,iplot2,iplot3,deltat,starttime,...
 dist,sensor,sensorx,sensory,sensorz,...
 srcloc,sourcesize,sourcetype,srcx,srcy,srcz);

% d:\DataWinNT\FY02LoneStarTX\Plot\plotasc.m
%
% Plots nchan channels of ascii data
% Does not call any subroutines
%

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% USA ERDC-CRREL, 72 Lyme Road, Hanover, NH 03755

nplot1 = length(iplot1);nplot2 = length(iplot2);nplot3 = length(iplot3);
xxmax = max(abs(xx)); %abs max for plotting

srate = 1/ deltat;%number of samples per second

% Find time window to plot
if(srcloc(3) == '4') %TC4 opposite side of sensors
 tstartpanel1 = starttime + 0.5; tendpanel1 = tstartpanel1 + 0.6;
 tstartpanel2 = starttime + 0.4; tendpanel2 = tstartpanel2 + 0.6;
```

```
 tstartpanel3 = tstartpanel2; tendpanel3 = tendpanel2;
elseif(srcloc(3) == '1') %TC1
 tstartpanel1 = starttime + 0.2; tendpanel1 = tstartpanel1 + 0.6;
 tstartpanel2 = starttime + 0.4; tendpanel2 = tstartpanel2 + 0.6;
 tstartpanel3 = tstartpanel1; tendpanel3 = tendpanel1;
elseif(srcloc(3) == '2') %TC2
 tstartpanel1 = starttime + 0.2; tendpanel1 = tstartpanel1 + 0.6;
 tstartpanel2 = starttime + 0.4; tendpanel2 = tstartpanel2 + 0.6;
 tstartpanel3 = tstartpanel1; tendpanel3 = tendpanel1;
elseif(srcloc(3) == '3') %TC3
 tstartpanel1 = starttime + 0.0; tendpanel1 = tstartpanel1 + 0.6;
 tstartpanel2 = starttime + 0.2; tendpanel2 = tstartpanel2 + 0.6;
 tstartpanel3 = tstartpanel1; tendpanel3 = tendpanel1;
else %Pistol
 tstartpanel1 = starttime ; tendpanel1 = tstartpanel1 + 0.6;
 tstartpanel2 = starttime ; tendpanel2 = tstartpanel2 + 0.6;
 tstartpanel3 = tstartpanel1; tendpanel3 = tendpanel1;
end

% time series
tend = length(xx(:,1)); %all data
t = starttime + (1:tend)/srate;

% Start of data plot %***************************************
nametext = ['NZ Data - 3 panel']; %----------FIGURE - 3 Panels
f1 = figure('Name',nametext);
set(gcf,'Units','inches','PaperUnits','inches');

subplot(1,3,1); %Left (1st) panel of plot ------------------------
iplot=iplot1; nplot=nplot1;
%iplot=1:12; %Channels 1-12 %iplot=12:-1:1; %Channels 1-12
yshift = (1:nplot)*2 - 2;
ax = [tstartpanel1-0.05 tendpanel1 -1 2*nplot];
axis(ax);
ax1 = gca; set(ax1,'YTick',[]); set(ax1,'Box','on');
xlabel('Time, sec')
% plot data and label
hold on;
for i=1:nplot
 plot(t,(xx(1:length(t),iplot(i))/xxmax(iplot(i))) +yshift(i),'k');
 leftlabel = sprintf('%g',round(dist(iplot(i))));
```

```
 % Text labels for plot
 str1 = sensor(iplot(i),:);
 str2 = sprintf('%7.2e',(xxmax(iplot(i))));
 if (xxmax(iplot(i))) < 0.0001
 str2=sprintf('%4.1fE-6',(1E6*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.001
 str2=sprintf('%4.2fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.1
 str2=sprintf('%4.1fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 10.0
 str2=sprintf('%4.2f',(xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) > 1000.0
 str2=sprintf('%4.1fk',( xxmax(iplot(i))/1000 ));
 else
 str2=sprintf('%4.1f',(xxmax(iplot(i))));
 end %text loop
 str3 = char(str1);
 str4 = char(str3 , str2);
 str5 = cellstr(str4);
 text(tendpanel1+0.02,[yshift(i)],str5,'FontSize',8,...
 'HorizontalAlignment','left');
end %plot loop i=1:nplot %Left (1st) panel of plot ------------------

subplot(1,3,2); %Center (2nd) panel of plot ------------------------
iplot=iplot2; nplot=nplot2;
yshift = (1:nplot)*2 - 2;
ax = [tstartpanel2-0.05 tendpanel2 -1 2*nplot];
axis(ax);
ax1 = gca; set(ax1,'YTick',[]); set(ax1,'Box','on');
xlabel('Time, sec')
% plot data and label
hold on;
for i=1:nplot
 plot(t,(xx(1:length(t),iplot(i))/xxmax(iplot(i))) +yshift(i),'k');
 leftlabel = sprintf('%g',round(dist(iplot(i))));
% Text labels for plot
 str1 = sensor(iplot(i),:);
 str2 = sprintf('%7.2e',(xxmax(iplot(i))));
 if (xxmax(iplot(i))) < 0.0001
 str2=sprintf('%4.1fE-6',(1E6*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.001
```

```
 str2=sprintf('%4.2fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.1
 str2=sprintf('%4.1fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 10.0
 str2=sprintf('%4.2f',(xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) > 1000.0
 str2=sprintf('%4.1fk',( xxmax(iplot(i))/1000 ));
 else
 str2=sprintf('%4.1f',(xxmax(iplot(i))));
 end %text loop
 str3 = char(str1);
 str4 = char(str3 , str2);
 str5 = cellstr(str4);
 text(tendpanel2+0.02,[yshift(i)],str5,'FontSize',8,...
 'HorizontalAlignment','left');
end %plot loop i=1:nplot %Center (2nd) panel of plot --------------

subplot(1,3,3); %Right (3rd) panel of plot ------------------------
% Pressure sensors only
iplot=iplot3; nplot=nplot3;
yshift = (1:nplot)*2 - 2;
ax = [tstartpanel3-0.05 tendpanel3 -1 2*nplot];
axis(ax);
ax1 = gca; set(ax1,'YTick',[]); set(ax1,'Box','on');
xlabel('Time, sec')
% plot data and label
hold on;
for i=1:nplot
 if(xxmax(iplot(i)==0));xxmax(iplot(i))=1;end
 plot(t,(xx(1:length(t),iplot(i))/xxmax(iplot(i))) +yshift(i),'k');
 leftlabel = sprintf('%g',round(dist(iplot(i))));
 % Text labels for plot
 str1 = sensor(iplot(i),:);
 str2 = sprintf('%7.2e',(xxmax(iplot(i))));
 if (xxmax(iplot(i))) < 0.0001
 str2=sprintf('%4.1fE-6',(1E6*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.001
 str2=sprintf('%4.2fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 0.1
 str2=sprintf('%4.1fE-3',(1E3*xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) < 10.0
```

```
 str2=sprintf('%4.2f',(xxmax(iplot(i))));
 elseif (xxmax(iplot(i))) > 1000.0
 str2=sprintf('%4.1fk',( xxmax(iplot(i))/1000 ));
 else
 str2=sprintf('%4.1f',(xxmax(iplot(i))));
 end %text loop
 str3 = char(str1);
 str4 = char(str3 , str2);
 str5 = cellstr(str4);
 text(tendpanel3+0.02,[yshift(i)],str5,'FontSize',8,...
 'HorizontalAlignment','left');
 % Write title for right panel
 if(i==nplot)
 text(tstartpanel3+0.05,yshift(i)+1.1,'Pressure Sensors',...
 'VerticalAlignment','bottom');
 end
end %plot loop i=1:nplot %Right (3rd) panel of plot --------------

% Title for entire plot ---------------------------------------
if(sourcesize~=0) %C-4 shot
 plottitle = ...
 sprintf('TX02 -- %s Rec %g -- %s %3.1f kg %s %3.1f m agl -- %3.0f-%3.0f
m',...

fname,shotnum,srcloc,sourcesize*1.25/2.2,sourcetype,srcz,min(dist),max(d
ist));
else %not C-4 shot
 plottitle = ...
 sprintf('TX02 -- Record %g -- %s %s %3.1f m -- %3.0f-%3.0f m',...
 shotnum,srcloc,sourcetype,srcz,min(dist),max(dist));
end

ax=axes('Units','Normal','Position',[0.075 0.075 0.85 0.85],...
 'Visible','of');
set(get(ax,'Title'),'Visible','on');
title(plottitle,'FontSize',18,'FontWeight','Bold');

set(gcf,'PaperUnits','inches');
set(gcf,'PaperPosition',[0.5,0.25,10,7]);
set(gcf,'PaperOrientation','landscape');
```

```
return
```

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The effect of forests on low frequency military noise propagation is unknown. As part of a joint project, ERDC-CERL and ERDC CRREL conducted measurements at the Lone Star Army Ammunition Plant located in Texarkana, Texas, to investigate these effects. In this report, the short-range measurements conducted by ERDC-CRREL are documented. Blast noise waveforms produced by C4 explosions at distances from 30 to 567 m were recorded and are presented in this report. In all, 42 different explosions were recorded, producing 314 high quality pressure waveforms for analysis. Additional reports documenting the long-range measurements and analyzing the recorded data are in preparation.

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